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TABLE OF LEADING ARTICLES.

The Vindication of John W. Hill.................. 61
High-Grade Equipment 61
Reinforced Concrete and Tile Floors.............. 62
The Meeting of Cement Users.................... 62
The District Pumping Station at Washington, D. C. (Illustrated) 64
Government Contracts: Legal Pitfalls and How to Avoid Them.—VI. 66
Cleaning the Old Sand Water Filters at Hudson. (Illustrated) 69
The Electric Locomotives for the St. Clair Tunnel. (Illustrated) 71
Frederic Pike Stearns. (Illustrated).............. 73
Standard Plate Girders on the Chicago, Milwaukee & St. Paul Railway. (Illustrated)................ 74
The Protection of Small Harbors on Lake Michigan 75
A Reinforced Concrete Shoe Factory in Brooklyn. (Illustrated) 78
The Cienfuegos Screw Pile Pier. (Illustrated).... 80
The Mechanical Plant of the Hotel Belmont, New York.—VI. (Illustrated).......................... 81
A Long Wire Sweep for Soundings................ 83
Book Notes 84
Reduction in the Thickness of the Walls of Standard Steam, Water and Gas Pipe. (Illustrated)........ 85
Good Looks 85
Tests of Portland Cement Containing Large Percentages of Gypsum.............................. 86
The Haverstraw Landslip. (Illustrated)............ 86
Marsh Roads 86

The Vindication of John W. Hill.

Readers of this journal who fail to examine the statement made by the presiding judge at Philadelphia last week when he ordered the jury trying Mr. John W. Hill, former chief of the Bureau of Filtration, to bring in a verdict of "not guilty" on every count against him, will miss a most instructive comment on the responsibility of a chief engineer. The statement referred to is printed in the Current News Supplement of this issue. It completely exonerates Mr. Hill from all criminal charges and leaves him entirely free from the reckless assertions apparently brought against him for political purposes. But it cannot in any way compensate him for the long period of silent suffering which he was forced by his counsel to endure until they could bring his case to trial. Very wisely he obeyed the injunctions of his lawyers to refrain from comment on the accusations made against him during the political pot-boiling of last fall, for his vindication at the present time is more complete and thorough. Nevertheless the tedious period of silence in the face of accusations which the judge at Philadelphia has just declared without the slightest basis is not repaid by the great enthusiasm with which the court's announcement was received nor by the hearty sympathy of engineers all over the country ever since he was removed from office. Such a strain on a man's vitality has an effect so lasting that those who put him on trial on these unwarranted charges must despise themselves for their injustice.

The trial of Mr. Hill has been the most notable case of criminal proceedings against a civil engineer for many years. It was initiated at a time when politics were making a large part of the people of Philadelphia act in a crazy manner. Probably there were ample reasons for being disgusted with municipal administration in the city; even when nine-tenths of the assertions in the yellow newspapers and still more yellow cheap magazines are disregarded, enough claims for reconstructing the city administration remain to warrant trying a new set of officers. The new officers saw that the largest contracts then in progress were held by people affiliated with the former dominant political faction, and at once attacked these contracts. Mr. Hill, as the engineer in charge of the work, was attacked as the man who made it possible for the contractors to reap a rich harvest by illegal means. He happened to be in the path of the "reform" wave and it broke over him. Any other engineer on the work would have suffered in the same way.

Now that he has been freed from all the charges, a word must be said to show the peculiar cruelty of the reckless accusations in his case. Years ago he was a mechanical engineer, making a specialty of pumping machinery. In this way he was led to take up the general problems of water-works construction. He practiced in Ohio and built up a professional business of considerable extent. Some years ago, he lost a son by typhoid fever, and ever since that time the purification of water supplies has been something far more to him than a phase of engineering; it has been a life study to which he dedicated all his spare time in order that others might be spared the deep affilication which he suffered. This statement will explain to many people the reason of his constant reference to and interest in everything that is connected with the subject; it was more than a hobby and was grounded in a far deeper motive than professional curiosity. His connection with the filtration works of Philadelphia therefore ensured to the city the services of a man particularly fitted by training and temperament to carry out the works for the purification of the supply of that place.

The contracts for the works were let at high figures, higher than they would need be to-day. When the first contracts were made, however, such construction was little known in this country. There was considerable uncertainty as to the cost of carrying it out on a large scale and under the conditions that always make municipal work expensive to contractors. Mr. Hill had nothing to do with the prices at which the contracts were made. His duty was to see that the work was done properly and that the contractors were not illegally paid. The criminal charges against him were based on the assertion that he authorized illegal payments to the contractors, but the trial judge has just declared such talk to be wholly unfounded.

There remains to be settled the matter of the character of the work. Little was said about this in the proceedings against Mr. Hill, as it will come up in the actions of the city against the contractors. The construction of these great works has attracted the attention of engineers all over the country. Engineering visitors were always welcomed by the city's representatives and by the contractors. Not a day passed but what visitors were on some part of the work who were competent to judge of its quality. Yet with all this publicity, The Engineering Record never heard any criticism that was not favorable about the manner in which the construction was carried on. The works as a whole are probably as well built as any in the country. It is equally probable that there are minor defects in them. In undertakings of magnitude such defects are bound to occur. They have already been detected, it is said, in parts of the Philadelphia structures, but the information thus far made public indicates that they are merely such minor matters as it is unfortunately necessary to expect in work done by poor mortals here below. Some of the work might have been done better, possibly, but unless the forthcoming proceedings against the contractors bring to light defects of greater weight than any yet proved, this episode in engineering work will simply prove how reckless men of intelligence and honest intentions may become for the sake of playing the political game successfully.

High-Grade Equipment.

A number of instances of the installation of costly high-grade equipment have come under the observation of The Engineering Record lately that suggest comment. They embrace a considerable range of apparatus, both in machinery and power plant work. In each case they were displayed with pride as the latest labor-saving thing of the kind, and in each case they were not in use when shown. In fact it was learned that they were not in regular use, but put in for occasional operation. The thought that they were out of place must have occurred to all who saw them who were accustomed to examine the total figures of operation before deciding on the value of equipment for a given purpose.

The degree of perfection to which labor-saving apparatus has been brought is a mark of progress in which we may all take pride. The trade publications which describe tools that run themselves and power plants that attend to their wants almost automatically are most interesting reading. These new improvements cost a lot of money, however, for it is necessary for their makers to charge not only their cost and a fair profit, but also a sum that will pay the development expenses incurred while they were being designed and tried out before coming on the market. These charges are often very high. Consequently the operating charges of the new equipment may be very high unless it is run steadily so as to secure the maximum steady output of which it is capable. In a few cases, such as presses for newspaper printing, the aim is to produce a great output in a short time; everything is designed for that end, for it is known at the outset that the presses will run but a few hours a day. The object is to get as much from them in that time as possible. As a rule, however, these time requirements do not enter into the problem, which is merely one of getting the most returns from the labor of the men.

The cost of production depends on the fixed charges, materials and labor. It makes no difference whether the product is merchandise, water delivered into the mains of a city or electricity supplied to its residents. It is perfectly possibly to cut down the labor charges by putting in automatic machinery, but other expenses will rise in doing so in many cases. The assertions of manufacturers of improved apparatus that their machines will enable a man to turn out a quarter more product per day may be perfectly true, but of what value are they when there is no demand for more of that particular product? It is not likely that their installation will save enough labor to pay the additional fixed charges in many cases. It may be perfectly true that a pump will furnish water more economically that another costing less money, but as the plant is run only a few hours a day, the economy in steam consumption is more than offset by the interest on the more economical equipment. The same is true of equipment for electric lighting needed but a short time per day. After paying for a good unit of a simple character, the additional expense necessary to put in one of high-grade seems unwarranted in many cases.

It is perfectly natural for the owner of a plant to wish to have the best there is. The trouble lies in the fact that what is best for the man who will run a piece of apparatus steadily may not be at all the best for occasional operation. This is an axiom that would not be worth mentioning were it not for the fact that in a number of recent cases of improvements with which this journal is familiar it has been overlooked.

Reinforced Concrete and Tile Floors.

Among the many applications of reinforced concrete to engineering construction there is none more useful nor one in which the peculiar features of that material find more suitable application than in the floors of buildings. The prime requisites of a good floor for modern substantial buildings are combined lightness and solidity, with the highest possible fire-resisting capacity. This latter must be insisted upon under all conditions. A fire-resisting floor will not in itself save a building from destruction in a conflagration, but it will aid much in retarding the progress of a fire and in guarding against the general destruction caused by any fire starting in the interior of a structure.

Probably the strongest objection to the introduction of masonry floors in connection with steel beams has been based upon their great weight, as is shown by the fact that the efforts in this particular class of construction have continually been and still are directed toward such designs as will decrease weight without trenching upon strength or solidity. Any light material which forms a sufficiently strong concrete, such as cinders, has been generally employed wherever it has been obtainable; but even that has not been sufficient to meet all the requirements of the case. The distribution of the structural material is at least as important as its quality and general character. As long as concrete itself has constituted the entire sustaining material it has been imperative to use it in a massive way in consequence of its incapacity to resist tension to any material extent. The application of reinforced concrete to floor construction has, however, radically changed that feature of the case. When it became possible to use a masonry beam with comparatively high tensile capacity in its lower portion the arched or massive form was no longer necessary. Manifestly nothing else can be as light in a floor as void space, and that has practically become available in modern floor construction.

It does not always consist with desirable effects to show the void portions of the floor constituting a large percentage of the floor volume, although floor arches have frequently been so used as to expose the under-arch spaces. It is frequently, if not usually, advisable to show a flat ceiling as well as a level floor and the reinforced concrete construction enables this to be done in a number of ways. The concrete-steel beams need be placed little or no nearer together than those of steel, and any one of the many plaster-carrying devices may be used for the ceiling. While this does not accomplish the purpose of solidity in all respects, it is a satisfactory method of procedure.

It is probable that the combined reinforced concrete and tile floor recently constructed in the new portion of the Marlborough Hotel at Atlantic City, is as satisfactory an instance of a thoroughly solid and materially lightened floor as recent construction has furnished. This complete building, as well as the floors used, was described in detail in The Engineering Record of Dec. 23 and 30. This type of construction utilizes in a thoroughly effective manner the distinct advantages of reinforced concrete floor construction and at the same time secures the material advantage of solidity by placing cellular floor tiles between the concrete-steel floor system in such a manner as to gain at least some sustaining strength for the floor through the presence of the tile work. The tiles afford a large amount of air space and thus lighten the entire construction to a substantial extent. A flat surface is afforded for the ceiling, constituting the under surface of the floor, as well as the usual level concrete surface on which to lay the floor, which may be of any suitable material. This particular case, as well as those of well-designed concrete-steel constructions in general, illustrate the extent to which careful scientific design may be carried in floor work, and so secure in a rational engineering manner all the advantages of economy, stiffness, strength and lightness, as well as a material which is as nearly fireproof as any now available for building construction. The masonry portions of such floors are now subject to as precise and accurate computations as those controlling the design of the steel beams themselves. Under proper design and suitable careful manufacture and putting in place of the materials, these floors embody an excellent and effective distribution of material calculated to develop the peculiar resisting capacities of each component and forming a consistent whole.

One of the peculiar features of this entire Marlborough Hotel construction, including the exterior walls as well as the floors, illustrates a feature of concrete-steel construction to which attention is not ordinarily called. It was necessary in this case that the guests of the older part of the hotel should not be disturbed by the disagreeable and wearing noise necessarily attendant upon the fabrication of steel structural work. The driving of rivets and other attendant noises would probably have been destructive of the hotel's business while the new building was in progress. The fabrication and putting in place of the reinforced concrete walls and floors was accomplished essentially without noise and without disturbing to any sensible extent the quiet surroundings so desirable for the occupied older portion of the hotel. It is not unlikely that this particular characteristic of concrete-steel construction may enhance demand for it in other quarters.

Another advantage of reinforced concrete construction that is allied to the one just mentioned is the practicability of adding to the height of such a building without interfering in any way with its customary use by the tenants. This presupposes, of course, that the building has been so designed that the additional stories may be added without imposing too great loads on the older portions. In several cases recently under consideration one of the most important merits of reinforced concrete in comparison with steel construction was this freedom from noise and annoyance to tenants in any future additions of higher stories.

The Meeting of Cement Users.

There has been a good deal of curiosity expressed concerning just what purpose could be served by the meeting of the National Association of Cement Users at Milwaukee last week. Nobody has seriously proposed a meeting of steel users or a gathering of lumber buyers, and there have been frequent inquiries concerning what object such a gathering could have that was in any way distinct from the objects of engineering and architectural societies and organizations of contractors. The report of the meeting published in the Current News Supplement of this issue will make clear the peculiar conditions which render an association of cement users desirable at this time. These conditions all hinge on the fact that the Portland cement industry in this country has developed with such enormous rapidity that there is danger of its product being misused and its value undermined in popular opinion by those who seek to employ it where it should not be used or in ways that are not advisable.

The primary object of the society when it was organized was to bring together the makers of concrete building blocks. Their manufacture has been developing so rapidly as to cause apprehension lest poor blocks be turned out in quantities that will blight the infant industry. There have been good grounds for believing that altogether too many poor blocks are coming on the market. The Engineering Record has seen blocks going into buildings in several parts of the country which were wholly unfit for the purpose, being so soft and porous as to surely waste away rapidly under the influence of the weather. Moreover, the form of some of the blocks was such as to prevent any good architectural effect. An association which will bring together the makers of such blocks, the representatives of cement manufacturers and the makers of concrete block machinery will manifestly accomplish much good in spreading a knowledge of sound practice in the use of cement and concrete. The National Association of Cement Users accomplishes this purpose and deserves hearty support on this account. Its convention last week was held under trying conditions, owing to limited accommodations for exhibits; the reasons for this condition are explained in the report of the convention, and the Association has taken steps which will prevent its repetition. This is a most important subject, for the exhibits are a valuable feature of such a gathering, affording to the block makers who attend an unusually good opportunity to become acquainted with all the apparatus of their industry.

Other features of the convention indicate that the attempt to make the organization lap over into the field of the engineering societies is of problematical success. If the apers and discussions interest the contractors for concrete work sufficiently to bring them together, a very important field of useful work should be developed. One of the most serious problems in reinforced concrete to-day is the inability of many contractors to appreciate the necessity of careful workmanship. These reinforced concrete structures must be built with great care in placing the reinforcement, preparing and placing the concrete and curing it after it is in place, yet many works are executed with no more care than is considered necessary in constructing a retaining wall or the foundation of a pavement. Readers of this journal have doubtless seen the slender columns of reinforced concrete buildings exposed to bright sunlight and strong winds which dry them out altogether too fast, although the makers of concrete blocks have already learned that curing is one of the most important features of their manufacturing process. An association which will bring together the contractors for reinforced concrete and the makers of building blocks ought to prove of decided value on account of the information that can be mutually exchanged.

On the other hand, any attempt to make the association an organization for the exchange of opinions concerning the design of reinforced concrete and similar subjects is likely to decrease the interest of those members who will gain most by attending the sessions. It was noticeable at the convention last week that the engineering papers were not listened to with much interest, while those on the contracting side of the concrete industry were followed carefully. In view of the fact that there are ample facilities for discussions of all engineering aspects of concrete structures at the present time, it would seem that this new society will do well to develop the important field of concrete contracting and let concrete engineering alone. This does not mean that engineers will not have an important part to play in the discussions, for they will have an unequalled opportunity of presenting the importance of careful attention to details of construction as required in the specifications. If engineers in attendance at the meetings will insist on the necessity of careful workmanship as well as good materials in reinforced concrete construction, the contractors will learn that such work is not so simple as it seems. This will lead them to estimate the cost properly and to insist on being paid higher prices than rule today. Contractors must learn that, in raising the quality of their work, there will be no objection from engineers if prices are also raised. An organization that will spread these ideas deserves hearty support.

Notes and Comments.

A Blue-Print Problem that is pressing for solution for several important purposes is a way to change the blue color to some other, which can be photographed more clearly. A green will answer, for example. It often happens that an engineer will receive blue-prints on several scales from which he must work up assembled drawings. Where a camera of even moderate size is available, it will often prove desirable to reduce these blue-prints by photography to the scale of the assembled drawing and then make prints from these negatives which can be traced directly. In many offices, also, the use of large sheets and large blue-prints has been given up entirely. When such drawings come into the office and it is desired to preserve them, they are photographed down to one of the standard sizes and the important lettering put on in such a way as to be legible, if it is too fine in the reduced print. Unfortunately it is difficult to secure even moderately fair negatives from some blue-prints, and the problem of changing the color from blue to another tint is accordingly worth the consideration of some chemist who is willing to do a little investigation which will bring nothing but increased reputation or a very moderate financial return if it is successful. Some success has been attained in changing the blue to a green which can be photographed readily, but unfortunately the green color soon fades away, leaving a sheet of blank paper, which makes the process of only occasional use.

The Effect of Automobiles on roads has recently been receiving more attention in this country than it did a couple of years ago, when complaints were first made in Europe concerning the way in which the tires of these cars pumped the fine material from between the stones of the surface of the road. Governor Stokes, of New Jersey, has recommended a tax on automobiles in order to pay part of the expense of road maintenance, and the New York State Automobile Association has recently passed a resolution reading as follows: "Resolved, That, as the sense of the New York State Automobile Association, such association should accept a reasonable provision of law looking to the motorists of the State paying a share of the cost of maintenance of all improved highways built by State aid, provided such maintenance is made by the State." According to Mr. Albert R. Shattuck, there are now about 30,000 cars in the State, and an annual license of $1.50 each would bring in $45,000. There are about 700 miles of State aid roads, so that this tax would contribute about a third of their average cost of maintenance; in view of the very small number of cars in proportion to other vehicles this amount seems to be fair.

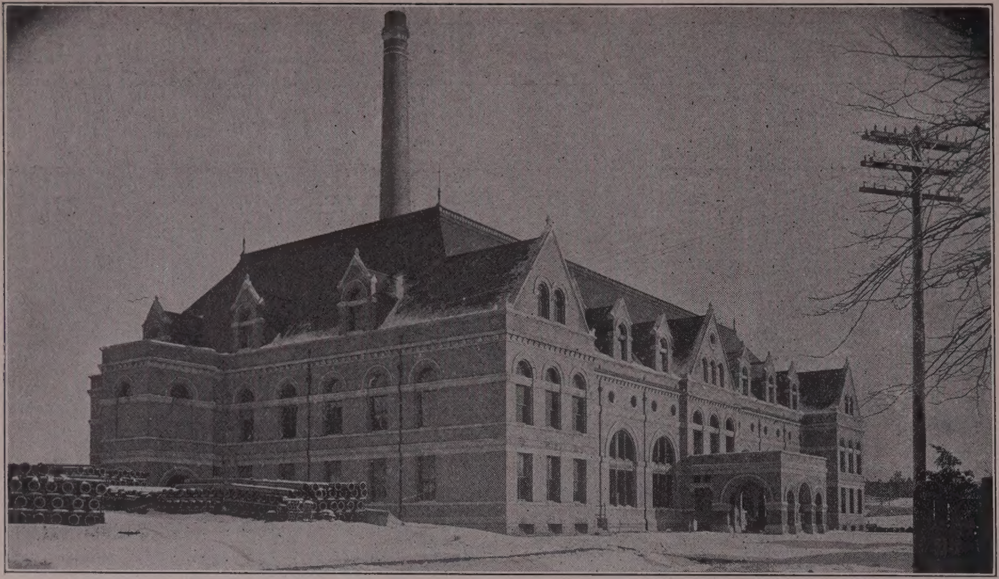
Power from Victoria Falls continues to agitate the British electrical engineering world, and the lines between the advocates and critics of the scheme are being drawn more clearly. There are some interesting things to be said for the project, and these are being said very cleverly, but when the substance of the argument is critically examined it seems of too light texture to clothe an undertaking requiring millions of pounds with an appearance attractive to capitalists. The project contemplates the generation of 20,000 h.-p. at the Falls and its transmission about 745 miles to the Rand. It is proposed to use the direct-current system worked out by M. Thury and described in The Engineering Record of Aug. 6, 1904, and the cost of the transmission lines alone is estimated at £2,000,000. It was recently pointed out in this journal, in some articles on the Rhodesia Ry., that coal suitable for steam purposes is readily obtained in localities much closer to the Rand than Victoria Falls. It is even stated by Mr. Robert Hammond in the Engineering Supplement to the London "Times" that coal of 11,000 B.t.u. calorific value can be delivered at any point in the Rand for 10s. 6d. a ton. It is manifest, therefore, that if these figures are correct the total interest, maintenance and depreciation on the transmission line from the Falls makes the project financially crazy, irrespective of the cost of generating current at the Zambesi River. A good deal has been said lately about the trouble such a plant would experience from disturbances due to lightning, a subject discussed in its South African aspects in a valuable paper before the Institution of Civil Engineers about four years ago, but it may be safely said that such technical troubles would be nothing in comparison with the difficulty of earning a dividend on any such long transmission system in the face of cheap coal.

The Chemistry of Cements is considered of sufficient national importance for the Prussian government to join with the Society of German Portland Cement Manufacturers in offering prizes of a total value of about $750 for essays on the subject. The topics to be considered are the following: First, to prove whether silicic acid, alumina and oxide of iron combine with lime as crystalloids in stable proportions, or as colloids in varying proportions. Second, To prove whether double combinations result between silicic acid, alumina and oxide of iron with lime, and in what manner these substances take part in the hardening process. Third, Consideration of the swelling phenomena which accompany the hydraulic hardening. Fourth, Consideration of the influence of the temperature and the duration of the burning process on the different kinds of hydraulic cements. Fifth, Properties of puzzolana and its hardening with lime. The papers must be written in German and be delivered under a nom de plume to the Minister of Public Works of Prussia before the close of the year. It will be noticed that a considerable number of the topics are included in the research work which Mr. Clifford Richardson has lately been carrying on, and it will be interesting to observe how nearly the papers which are given prizes in this competition express results in harmony with those of this investigator. It might be added that a very important paper by him, on the hardening of cement, is in course of publication by the Office of Public Roads, and it is understood that it will show with the aid of admirable microphotographs the nature of some of the most interesting steps in the phenomenon of setting.

Pneumatic Tools have recently received an unexpected but deserved mark of approval by the agreement of the Workmen's Society with the Federated Shipbuilding & Engineering Employers of England and Scotland, to encourage the use of these appliances and to allow a substantial reduction in rates of pay for work done by their aid. Hereafter men using pneumatic tools wil have their pay reduced 40 per cent. on shell plating and 35 per cent. on interior work generally. Such a concession would manifestly not be made unless the workmen were certain by experience that it was just to both hand and pneumatic work.

Pickling Steel has been reported by a number of investigators to have a very bad effect on its quality, making it brittle, and this has been frequently stated of electro-plating effects on the metal. It has generally been held that this deterioration was due to the action of hydrogen in its nascent state, although some have held that the brittleness was due to the penetration of the acid into the mass of the steel. Prof. Charles F. Burgess of the University of Wisconsin has been investigating the phenomenon and his experiments, described in "Electrochemical and Metallurgical Industry," prove that the brittleness of pickled iron and steel is due to the action of nascent hydrogen rather than acid, and is a very serious matter where the metal objects are small.

Canal Construction by contract has been definitely adopted for a part of the Panama work by the Isthmian Canal Commission, according to announcements from a source of considerable reliability. This announcement has been expected, for parties associated with the work have been making investigations for some time past of the equipment and resources of many of the largest contracting companies. It would seem as though this method of executing the work were the best for a large part of it, for unless every official report on the subject is strangely at fault the bulk of the work is merely the excavation and disposal of large quantities of material under conditions which an experienced contractor is able to surmount. There may be portions of the work that will best be constructed by day labor under the direct supervision of the Commission's engineers, but the dredging and excavation can hardly come under this classification. No matter whether the work be done by the Commission or by contractors, it is desirable to repeal all restrictions concerning an eight-hour day and the importation of Chinese labor. This journal has objected to such requirements so frequently in the past that the arguments need not be repeated; they are based on considerations which need not be taken into account in a temperate climate, but have great weight when work is to be done on the Isthmus.



The New Pumping Station at Washington.

THE DISTRICT PUMPING STATION AT WASHINGTON.

By W. A. McFarland, Superintendent Water Department.

The District Pumping Station, formerly known as the Trumbull Street Station, of the city of Washington, is located on Bryant St. near Second, N. W., immediately south of the new city reservoir and filtration works. It is used for forcing water to such parts of the District of Columbia as are too high to be supplied directly by gravity from the clear water basin of the filtration plant; this territory includes all sections having an elevation of 70 ft. or more above mean tide. The station building is built of brick and Vermont blue marble; is 256x148 ft. in plan, and in addition to the pumping plant proper contains machine, carpenter, pipe-fitting and paint shops, meter-testing room, store-rooms and a number of office rooms. So far as is practicable, the working force of the department is concentrated at this point, the intention being to retain only the executive and clerical departments at the District Building.

Water is brought to the pumps at the station by means of a loop of 48-in. cast-iron pipe, with ends independently connected with the gate chamber at the reservoir. It is carried through the south side of the pump pit wholly above floor level, and has suitable outlets to the several pumps, each connected by a gate valve with hydraulic operating gear. As the pump pit floor is about 38 ft. below the flow line at the reservoir gate house, the suction main is under a positive static pressure of about 16 lb. per square inch. All pumping for Washington is now done at this station, the old U St. station having recently been closed.

Coal is handled by team and dumped into a hopper located under the roadway at the west end of the station. It then passes through a motor-driven rotary crusher and into a link conveyor with over-lapping buckets, also motor-driven, and is carried to and dumped into coal pockets located directly over the boilers. These pockets are nine in number, built of armored concrete supported on 60-in. plate girders, and have a total capacity of a thousand tons. From these pockets, which are designed to avoid dead spaces, the coal is drawn through double-lipped gates, operated from the boiler room floor by means of rods, into a down-spout arranged for weighing the charge, and capable of traversing so as to serve any one of four boilers. The outlets from the pockets are placed between boilers so that it is impossible to discharge coal directly to the stoker hoppers from the bins. In order to permit the emptying of any pocket and the transfer of coal, openings were located in the boiler room floor directly under the coal outlets, and a movable extension chute provided, by means of which coal can be passed directly to the basement and so into the lower run of the conveyor.

The boilers are 200 h.-p. horizontal water-tube type, arranged in batteries of two, and designed for a maximum working pressure of 200 lb. gauge. The final equipment will consist of eight boilers, and six are now installed. The boiler room is divided into two parts, practically independent of each other, is well lighted by large windows from the north, and has ample space around the boilers. In the middle are two fuel economizers with by-pass flues passing under the boiler room floor, through the basement, each economizer designed to serve four boilers. The main smoke flue is of brick with cast iron tee bars resting on the rear wall of boilers and on the wall of building.

Each boiler is equipped with a Roney mechanical stoker with an ash pit opening directly into a fire-brick-lined steel ash hopper in the boiler-room basement. These hoppers have controlling valves at the outlets, operated periodically by hand; they discharge into the conveyor. Ashes are carried to and stored in a concrete-steel bin located over the coal intake, from whence they are hauled by team. The coal used is George's Creek, run of mine.

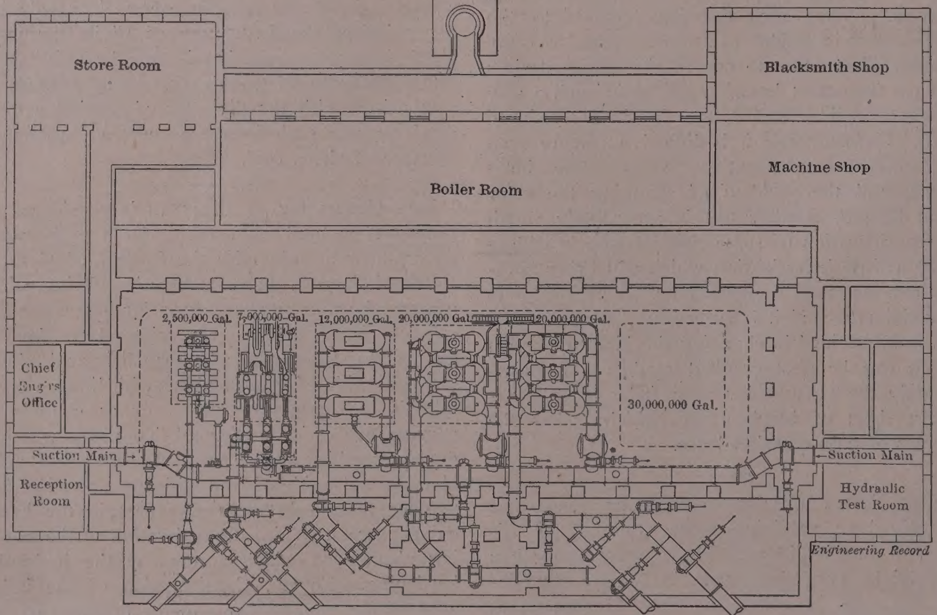
Feed water is normally forced into the boilers by feed pumps direct-connected to the main pumping engines. There are also two duplex direct-acting steam boiler-feed pumps located in the center of the boiler room opposite the economizers. The boiler feed piping throughout is of brass pipe, extra heavy iron pipe size, with extra-heavy cast-iron fittings, and is so arranged that the feed can readily be taken from either the direct-connected or auxiliary pumps, and forced either through, or by, the economizers. Here again each side of the boiler-room is independent of the other, with arrangements for cross-connecting. The pressure in the feed piping is regulated by gate valves placed at convenient points on the economizer fronts, and with relief valves so located that excessive pressure is impossible. The water from the air pump discharge on the main engines is wasted, clean water being always used for boiler feed.

With few exceptions, and these only in the smaller sizes, all high-pressure steam piping 6 in. and over in diameter throughout the plant has welded flanges, and all joints are made up with metallic gaskets. The steam piping forms a complete vertical loop, and as an additional precaution against the shut-down of any engine an auxiliary 4-in. header is independently connected with the boilers and the several engine branches.

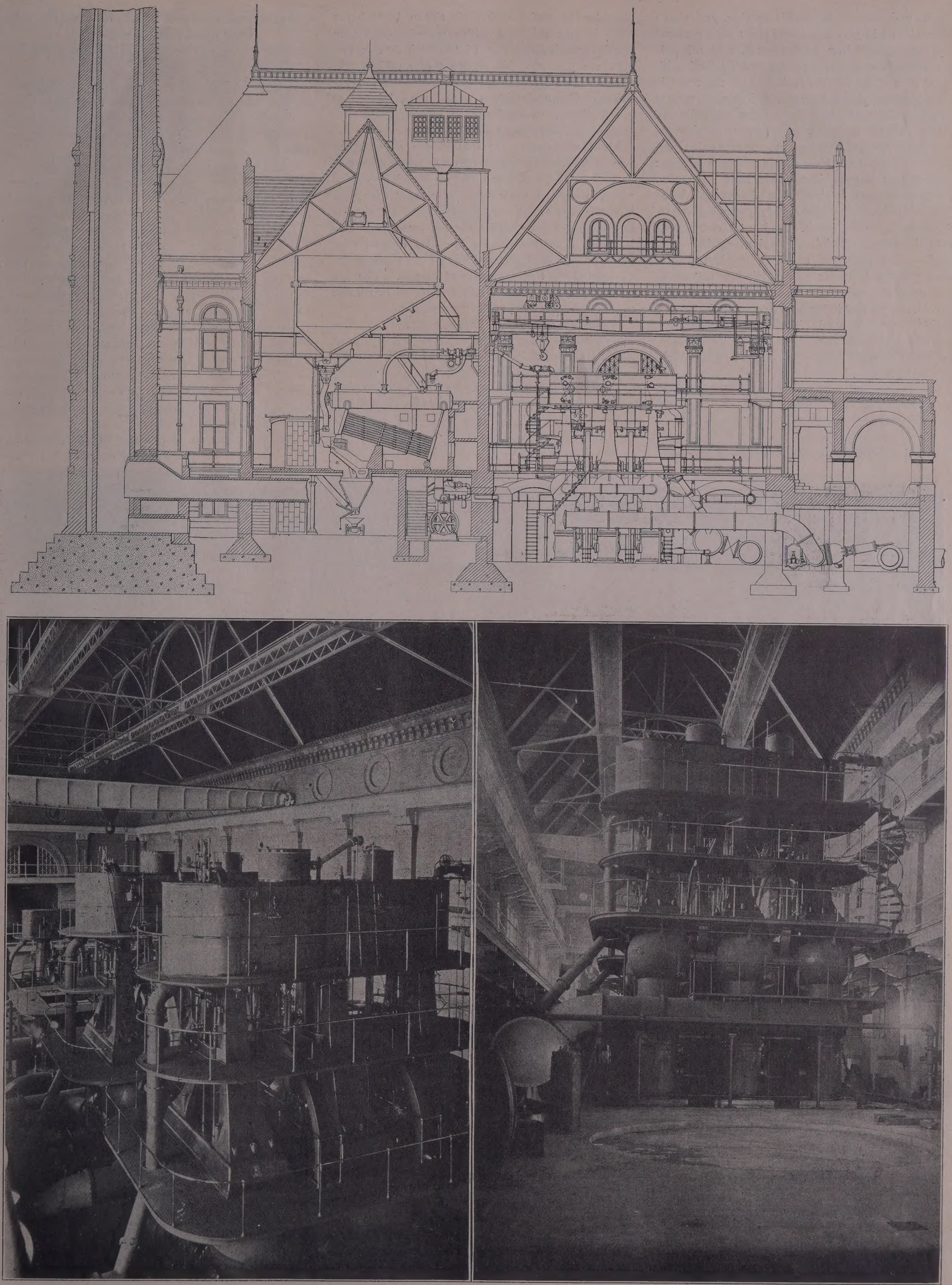
The Holly system for returning water of condensation to the boilers is used throughout. The main header over the boilers, 12 in. in diameter, is divided into four sections by gate valves placed horizontally, with stems extending through the party wall into the engine room, where they are fitted with hand wheels. At the highest point of each boiler branch is located a combined check and stop valve.

The engine room, 193x56 ft. in plan, was designed with a special view to securing light and ease of access to the various parts of the machinery; there are, therefore, no floors above that of the pump pit, the room being surrounded by two galleries and each pumping engine having all necessary galleries and stairs to give access to the various working parts.

From the pump pit floor to the working gallery, 18 ft. above, the walls are lined with white glazed brick; above the first gallery there is a



Plan of the District Pumping Station, Washington.



CROSS-SECTION OF PUMPING STATION AND TWO VIEWS IN ENGINE ROOM.

5½ ft. wainscot of Knoxville marble, and above this walls of impervious buff brick; all structural iron work, including roof trusses, and all gallery railings except on pumps are finished with white enamel paint. At each end of the room is a large open archway two stories in height, giving access to the main stair-halls from the galleries.

The present pumping eqeuipment consists of two 20,000,000-gal. vertical triple-expansion engines with double-acting outside packed plunger pumps, operating against a net head of 75 ft.; one 7,000,000-gal. horizontal triple-expansion engine with double-acting outside packed plungers operating against 170 ft. head, and one 2,500,000-gal. vertical triple-expansion engine with single-acting plungers, operating against 375 ft. head. There is under construction a 12,000,000-gal. vertical engine for 170 ft. head, and bids have been received for a 30,000,000-gal. vertical engine for 75 ft. head. The two small pumping engines described above will finally be replaced by much larger pumps to operate against the same pressures.

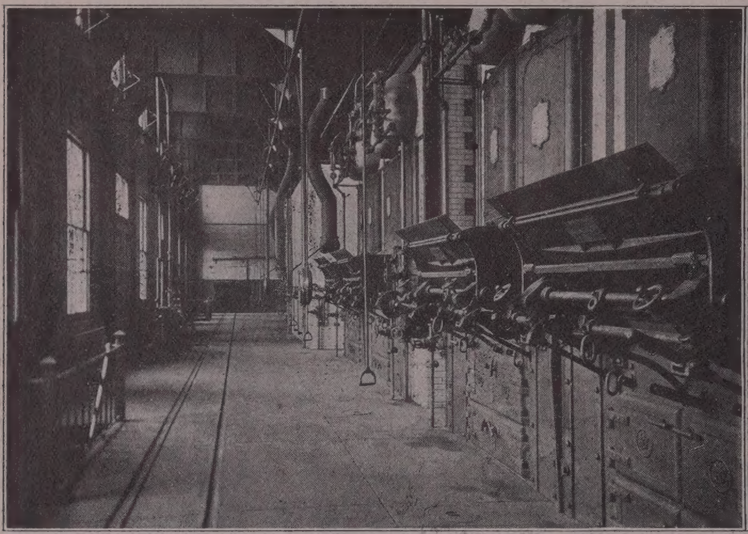
The entire engine room is served by an electric crane having a main hoist of 40,000 lb. capacity and an auxiliary hoist of 10,000 lb. At one end of the engine room at the level of the main gallery is a standard-gauge track entering the building from the north, crossing through the machine shop, and used for delivering heavy material under the engine room and machine shop cranes; this track extends only a few feet outside of the building where all material is delivered by team under a hoist extending over the roadway and track.

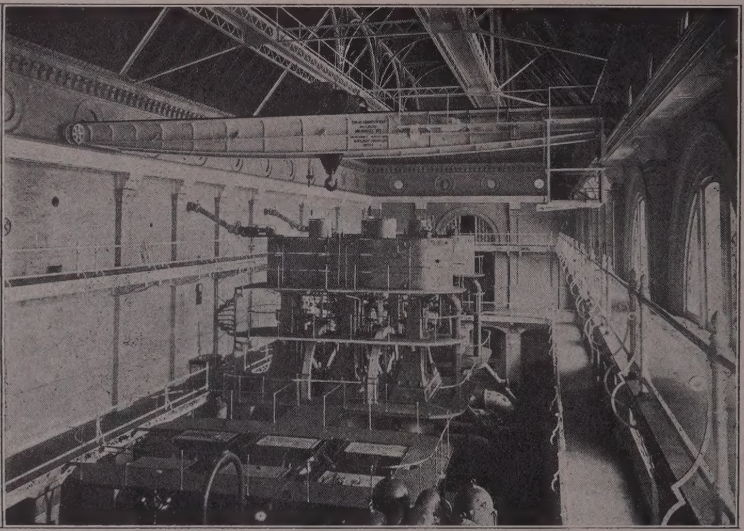
A feature of the station is the "valve vault," located in front of and parallel with the engine room, and extending under the sidewalk in front of the building. This vault is 185x27 ft. in plan and has 12 ft. clear head room. It is lined throughout with white glazed brick, and is separated from the pump pit only by piers supporting the walls. In it are cross-connected the discharge mains from the several pumps in such a manner as to permit the discharge from any pump to be diverted to the service above or below that on which it is normally used. All gate valves in this vault are solid wedge type, full bronze mounted; each is operated by means of a brass-lined hydraulic cylinder with bore one-half that of the main served; operated by the reservoir pressure of about 70 lb. per square inch. This pressure can be increased to 140 lb., if necessary; the lower pressure has proved sufficient up to the present time. Valve stems are of solid Tobin bronze with one inch diameter to each foot diameter of main, and each piston has also a solid bronze tail rod with cross-sectional area equal three-fourths that of the main stem; pistons are packed with square flax packing. As an additional precaution each main entering the building is fitted with a guard gate, located at a safe distance from the walls, and equipped with hand and electric operating gear.

Light and power for motors are supplied by two steam-driven direct-current 220-volt generators, one of 75 and one of 150 kw. The engine room is lighted principally by a row of 32-c.p. lamps spaced about 9 in. apart around the cornice and so wired that each alternate lamp only may be used if desired; lights are also located over archways around pump pit and at such points as needed on the engines and pumps. The use of only half the cornice lights is found to furnish ample light for all ordinary purposes.

As an adjunct to the pumping plant a machine shop has been equipped containing 42 in., 14 in. and 12 in. lathes, 60 in. boring mill, full universal drill press, shaper, small universal milling machine, wet and dry grinders, and other tools. On the second floor is a small wood working shop with universal wood-worker, band saw and lathe. All tools are motor driven.

For the use of the employes of the department a room has been set aside for use as a technical library, where all the principal technical periodicals are received and filed, and which is open to employes at all hours. It will probably be several years before the equipment of the station is finally completed.


Charging Floor of Boiler Room


Upper Part of Engine Room.

A Brick Chimney about 7 ft. square, forming part of the power plant of a manufacturing building in New York occupied by several tenants, lost about 30 ft. of its top in a gale a few days ago. It crashed through a part of the roof of that structure and also fell through several floors of an adjoining tenement house, the heavy cast-iron cap doing a lot of damage before it finally came to rest in a mass of wreckage on the third floor. The chimney had been guyed by a number of wires, which indicates that its stability was considered in doubt by the owners of the property, but these guys were not strong enough. The damage done to the building by the accident will doubtless amount to much more than the cost of putting the chimney in condition, and on this account the accident is a good lesson to the owners of other insecure stacks, who allow them to remain in service, a menace to life and a source of potential destruction to property.

Government Contracts: Legal Pitfalls and How to Avoid Them.—VI.

By George A. and William B. King, Members of the Bar of the Court of Claims.

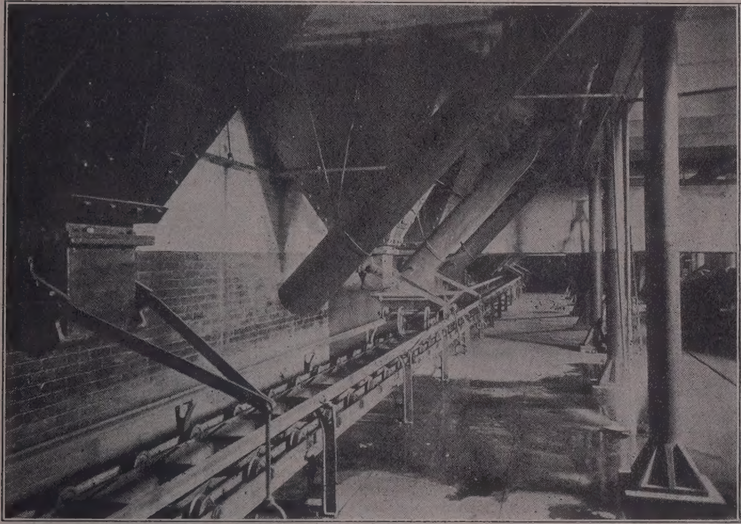
Receipt in Full.—It is a widely known principle of law that the payment of part of a debt is not ordinarily a discharge of the entire debt even if a receipt in full is given. The receipt is always subject to explanation.

The Supreme Court has declared that the rules for the decision of controversies in the Court of Claims under contracts between the government and its citizens are the same as those governing the relations between private individuals. We shall, therefore, not be surprised to find a series of cases in both these courts applying this old and familiar doctrine to such controversies. But we shall also find that owing perhaps to inherent differences between the government and individuals, some rules have been enunciated by the Supreme Court on the subject of receipts in full given by government contractors, which tend to enforce as to government claims a somewhat stricter rule on this subject than prevails under the established principles of law as to transactions between individuals.

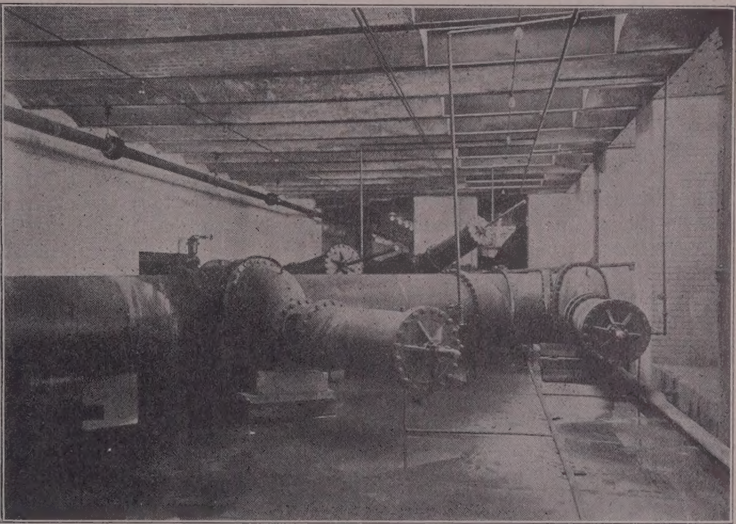
The first thing to do in order to learn the state of the law in this respect is to examine the decisions rendered by the Supreme Court and the Court of Claims.

Receipt not Conclusive.—The first cases to be considered are those in which the receipt in full has been held not to be conclusive of the contractors' rights; that is, where he has been allowed to recover an additional amount from the United States in spite of such a receipt.

The leading case on this point in the Supreme Court arose out of the occupation of certain land in the District of Columbia during the Civil War as an army hospital. The War Department promised to pay a rent of $500 per month for a year. Before the close of the year the owner was notified that the United States would pay only $250 a month for the future, including a portion of the original year. The land was occupied for several years. Only $250 a month was paid and monthly receipts in full were given without protest. In the suit for the difference the Supreme Court held that the receipt in full did not bind the owner for the remainder of the original year and that he could recover the difference during this time. The court summarized its view of the law on this subject by saying: "Payment by a debtor of a part of his debt is not a satisfaction of the whole, except it be made and accepted upon some new consideration."



Hoppers and Conveyor in Basement



View Inside Valve Vault.

The notice of the reduction of rent after the year and his signing monthly receipts in full thereafter without objection were held to constitute an acceptance on his part of the government proposition for the future. The court does not declare in this case the effect which a protest or objection, if made upon receipt of the notice of reduction of rent, would have had upon the owner's rights after its date. It would seem from its reasoning that it would have protected him at the rate fixed by the original contract.

A case in the Court of Claims very shortly afterward illustrated and applied the principle just quoted. A contract was made for the delivery of oats at a military post in the Indian Territory in 1875. The oats were delivered, but the government did not pay for them promptly. This resulted so to the financial embarrassment of the contractor that he could not continue prompt deliveries. The commanding officer at the post thereupon purchased oats at a higher price elsewhere, but did not follow, in doing so, the procedure required by the contract in order to charge the contractor. On the final payment the contractor was charged, in the face of his objection, with the difference in price. He signed the usual voucher, "in full of the above account." The Court of Claims considered the decision of the Supreme Court just cited and others on this subject and thus summarized the law:

"To make a receipt of part a discharge of the whole, there must be a new consideration, or a voluntary and well-understood compromise of a disputable and disputed claim, by which each party yields something for the concessions of the other; or an accord and satisfaction, by which a new contract is substituted, or a submission to arbitration; in each of which cases a consideration is expressed or implied. In the present case there was no new consideration for the discharge of the whole of the claimant's demand, no voluntary compromise, and no accord and satisfaction, from which a consideration can be implied. It was a simple payment of part when the whole was due and ought to have been paid; nothing more. The yielding was all on one side, which renders the receipt *nudum pactum* as to the unpaid portion of the claim."

It is particularly to be noticed in this case that the Court of Claims rested its decision upon the general rule that receipt in full following part payment is not payment in full and did not consider the objection which the contractor made to have been necessary to protect his rights.

A similar decision was made shortly afterward under a contract for transporting military supplies by steamboat on the Missouri River. Differences arose and a deduction in the nature of a penalty was made on the final voucher. This was receipted in full, but the contractors protested against the reduction. The court said also that the question in the case was one of the legal construction of a contract and therefore proper to be passed upon by the court. It was left uncertain whether without protest the claim could have been allowed.

In later cases involving penalties charged for defects and delays in clothing sold to the Indian Service and for delays in delivering a steamboat to the War Department, a receipt in full, accompanied by protest, did not prevent recovery in the Court of Claims.

Effect of Receipt Limited.—In other cases the Court of Claims has held that the effect of a voucher receipted in full does not extend beyond the items making up the voucher.

Thus a contract was made for the delivery of stone at the Indianapolis Arsenal. It was once inspected and accepted at the quarry, but afterwards inspected again at the arsenal, where part was rejected. A voucher was given for the stone then accepted and this was receipted in full. Upon claim being made for the stone then rejected, the court held that the receipt, being understood by both parties to cover nothing but the accepted stone, did not constitute a bar to the right to recover for the stone rejected at the arsenal.

A similar rule was followed in a later case arising under a contract for building a breakwater in Lake Michigan. Differences arose and, when claim was made on account of certain additional work required by reason of a variation from the original plans, the government pleaded a receipt in full, given upon the final estimates. The court treated the final estimates as conclusive, in the absence of protest, as to the items embraced in them, but not as to items not considered in them. Had protest been made, even the items embraced in the estimates would not have been closed by the receipt.

A similar decision was made recently by the Court of Claims under a contract for buildings at Fort Ethan Allen in Vermont. It was claimed that the final voucher receipted in full prevented the contractor from claiming any additional compensation. The court said: "In order that a settlement operate as an estoppel it must be shown that the subject matter of the subsequent contention was embraced within the purview of the settlement by the express action and contemplation of the parties. The policy of the law is to enforce settlements and thereby prevent litigation, but settlements are not to be inferred or presumed except upon substantial showing of facts indicating that the claim was embraced within the terms of settlement. A mere payment of what is due does not imply a settlement of disputed facts."

The heads of government departments have no right to allow claims for unliquidated damages such as losses arising from delays or improper interference where the damages must be estimated upon evidence. Since they cannot settle such claims, final payment and a receipt in full cannot be considered an offer of compromise and acquiescence in it. Therefore, the Court of Claims has held that a receipt in full does not bar a suit for unliquidated damages even if the receipt be not accompanied by a protest.

In the well-known litigation over the construction of the Naval Observatory at Washington, this question arose and the court declared "that the vouchers were not intended to cover those matters not within the province of the board to consider or the jurisdiction of the Secretary to allow." Since the Secretary was restricted in his approval to matters appearing on the face of the account, it was held that the contractor had a right to sue on other matters, notwithstanding his receipt in full.

The Navy Department has in some recent contracts incorporated a provision that the retained percentage shall be paid to the contractor only "on the execution of a final release to the United States, in such form as shall be approved by the Secretary of the Navy, of all claims of any kind or description under or by virtue of said contract."

A corporation executed a contract for certain work on a naval vessel, containing this provision. The president of the corporation was a lawyer especially conversant with the law relating to government contracts. Controversies arose and he offered to sign a release in the form required by the contract, with a proviso that it should not operate as a waiver of the right to sue in the Court of Claims. The Secretary of the Navy refused to approve this proposition and thereupon the receipt was signed in the stipulated form. The claims presented to the court were for damages for delay of a character which the Secretary had no jurisdiction to settle. Under these conditions the Court of Claims held that the release, if of any effect at all, did not release such claims.

The court seriously questioned whether this release had any legal effect, saying "that the minds of the parties did not meet in final settlement of the differences. Though the paper on its face appears to be a full and unequivocal release of all demands, the Secretary imposed terms which attempted to deprive plaintiff of money due to it, with notice from plaintiff of its intention to insist upon payment of a sum on account of the damage done. To make the receipt of a part the discharge of the whole there must be a new consideration, or a voluntary and well-understood compromise of a disputable and disputed claim."

Such a provision in any contract is properly subject to criticism as putting the government in an attitude essentially dishonest. "We concede so much to be due you," the government officer says, and adds, "but you cannot have it until you release everything else which you say is due, and which we deny." The fair course of any debtor is to pay the admitted debt without condition and to leave the rest to future settlement.

From all these cases the importance of written protest, whenever any disputed balances remain on final settlement, is the first practical lesson to be drawn. Protest is not always essential, but the cases where protest is not necessary cannot easily be differentiated and it is always safer that this precaution be taken. It need not be written upon the face of the voucher, but should be made at the same time.

Receipt in Full Conclusive.—The foregoing decisions have applied to the government the rule of private transactions that part payment, even when accompanied by a receipt in full, is not ordinarily payment in full. The rule is based upon the just principle that an honest debt should be paid in full. It would seem that where the government is a party, the rule should be construed broadly with the idea of paying all just debts without regard to technicalities. The government should not want to pay less than it honestly owes, even if a receipt in full has been signed.

The rule is subject in private transactions to some exceptions, chiefly arising out of two conditions, (1) that the part payment is accompanied by some new consideration for its acceptance as payment in full, or (2) that the claim made is open to doubt and the payment is accepted by both sides as a settlement of a dispute.

The same exceptions have been recognized in governmental transactions and applied by the Supreme Court in favor of the government with perhaps a greater degree of strictness than enforced in relation to private debtors. The cases following will show the practical application of these exceptions to decided cases of government contracts.

Disputes arose during the Civil War about a large number of contracts for supplying the army, charges of fraud were made and these contracts were sent by the Secretary of War to special military commissions for settlement. These commissions largely scaled the claims without great regard to the contractual rights of the parties and required the contractors to give receipts in full, as a condition to their receiving anything. The contractors afterward sued in the Court of Claims for the balances and their cases eventually went to the Supreme Court of the United States. That court held that a receipt in full, even when accompanied by a protest, showed the acquiescence of the contractor in the settlement of his disputed claim, as proposed by such commission, and that he was by that settlement precluded thereafter from asking redress in the courts.

In a later case the Supreme Court treated the settlement by the commission and the receipt of its allowance by the contractor as a finality, even when the contractor signed no receipt in full. This shows that the Supreme Court regarded the settlement as final because the claims were disputed and the offer by the government of settlement through the special tribunal was an offer of a final settlement, the acceptance of which bound the contractor to its terms. At least one of these claims was afterward considered by Congress on its merits and paid by special appropriation.

In a later case, where there was no special tribunal of settlement, the court took a step further. The Quartermaster's Department of the army entered into a written contract for hire of a vessel at a fixed sum per day and this was paid for a considerable period. The Quartermaster-General afterward notified the owner that he would be allowed much less than the contract rate from the date of the original hiring and that the amount already paid would be re-credited at the new rate. On final payment on this basis the usual formal voucher was signed "in full of the above account." The owner sued the government for the full contract rate and the Supreme Court declared that his receipt in full was "clear evidence that he agreed to take that balance in satisfaction of the claim."

It is impossible, in considering these decisions, not to feel that the Supreme Court was affected by circumstances peculiar to the times. The claims arose during the Civil War, the Treasury was deeply in debt, charges of great frauds in contracts were freely made, the right to sue the government had been newly given, administrative law was little understood, and the effectiveness of the Court of Claims as a means of defeating fraudulent claims had not been established. Severe decisions against contractors suing the government might very naturally have been rendered, which in calmer times seem to be contrary to recognized rules of law.

Later cases still further illustrate the effect given to a receipt in full under special circumstances. During the Civil War a military order was given for furnishing supplies to certain recruits. The price was not authoritatively fixed, but apparently the contractor and the officer who gave the order both understood that thirty-eight cents a man per day was to be paid. The government paid him twenty-eight cents and the contractor gave a receipt in full, but afterward sued for the difference. The court treated this as an uncertain contract, and held that the contractor acquiesced in the payment as in full, saying: "A receipt, as much as any other writing, is prima facie evidence of the fact it recites, and when it says that the payment was in full of any designated claim, it is proof of that fact, unless overthrown by other evidence in the case." Had a protest been made at the time of payment, the receipt would apparently not have been treated as a release.

In the winter of 1865 the army officer protecting the overland stage line was obliged to seize a large amount of hay for necessary army use. The owner presented a bill for $80 per ton, but the government allowed only $50, which the owner took without objection. As the government plainly intended this payment to be in full of an unliquidated debt and as the owner made no objection, he was presumed to have acquiesced in the settlement and accordingly was not allowed to recover. Had he protested, his claim would doubtless have been considered on its merits.

A contract was made in 1867 for excavation in the bottom of the Mississippi River near Rock Island. The contractor was obliged to remove the rock to an established grade and deposit it where required. Some rock was excavated below this and the engineer officer in charge allowed less than the contract price for it. A voucher was receiped by the contractor "in full payment of the above account." The contractor sued in the Court of Claims for the difference between the contract price and the price paid and the court held that the receipt in full was to be considered as an acquiescence by the contractor in the settlement of a disputable question. Here again a timely protest would have saved the contractor's right to be heard on the merits of his claim.

Under a contract for excavating a dry dock at Mare Island, Cal., disputes arose and the Secretary of the Navy annulled the contract. The contractor presented claims for additional compensation amounting to $57,294. The Secretary allowed $5,685 and the contractor gave a receipt in full. The Supreme Court, in passing upon the case, said that the claimant's acceptance without objection "was equivalent to a final settlement and compromise." This case again emphasizes the absolute necessity of protest. Congress subsequently passed an act authorizing the Court of Claims to consider this claim on its merits without regard to the receipt in full and the court rendered judgment for an additional sum three times as large as that allowed by the Secretary of the Navy. The rule originally enforced in this case thus deprived the contractor of what was justly due him.

A contract was made to cut wood at a military post in Dakota in 1869. The contractor was paid for what he did, but claimed damages because his teams had to be idle until a dispute was adjusted in his favor. The Supreme Court said that his receipt in full without objection showed an accord and satisfaction which prevented his asserting a claim before the courts. Here again a protest would probably have saved the contractor's rights.

The government made an emergency contract for locomotives during the Civil War and agreed to pay a minimum price, subject to increase by the rise in labor and materials. A claim for about $150,000 on this account was audited and allowed for less than $100,000. No receipt in full was signed, but the Supreme Court held that this was an offer by the Treasury Department in full satisfaction of the claim and that the acceptance of the money without objection was an acquiescence of the contractor, preventing any redress. This decision seems contrary to other decisions of the same court and to the recognized principle that payment of a part of a demand, without other circumstances, is not satisfaction of the whole. Here again a timely protest would have saved the contractor's rights.

Under a contract for building two ironclads, changes and alterations prolonged the work long beyond the contract term. No claim for damages for delay was made during the work and the contractor receipted in full. The Court of Claims held that this was an acquiescence.

The contractor for building a light house at Cross Ledge Shoal receipted in full without objection, but afterward claimed damages for delay. The court said that he lost his right to assert his claim.

Under a contract for building a road near the Vicksburg National Cemetery, disputes occurred and the Quartermaster's Department, on considering the disputed questions, fixed the amount due. The contractor receipted in full without objection and the court said that it was a mutual settlement of the disputed account, binding the parties.

Many similar cases since the year 1885, when the last cited decision was rendered, could be produced to show the necessity of protest when the payment is not of the entire sum claimed. Passing over many later cases, some further illustrations may be drawn from very recent cases, showing slightly different phases of the same subject.

When the buildings for the Naval Observatory at Washington were completed, the contractors rendered an account of various unsettled matters. The Secretary of the Navy made an allowance upon it and the contractors receipted in full with out protest at the time. The court held that the payment by the United States of all items included in this settlement was a complete discharge of liability on the account presented, although allowing some other items.

When the contractors for furnishing stone for two locks on the Illinois River were paid, they presented a protest, reserving claims for extra work and for losses occasioned by delay. They presented these two claims to the Court of Claims and a third claim for losses from the omission of work contained in the original contract. The Court of Claims said that claim could be made only for the items mentioned in the protest, since this implied acquiescence in all the other items.

Under a contract for a bridge at Rock Island, some work was ordered which the contractor claimed to be extra. Upon final settlement the government claimed penalties for delay. The voucher for final payment neither allowed for extra work nor deducted penalties and the officer in charge required the receipt to acknowledge payment "in full for all charges, claims, adjustments, services or other alleged indebtedness." The court held that this receipt was a finality since it was evidence of a compromise between the parties where each had conflicting claims.

Washing Large Stones in Tubs, Hudson Water Filters.

Conclusions.—It cannot be said that the decisions cited are altogether consistent; still, a careful review of them permits some practical conclusions to be declared with reasonable confidence.

1. Payment by the United States of a part of its debt to a contractor is not a satisfaction of the whole except it be made and accepted upon some new consideration.

2. A receipt in full given by a contractor, even without protest, is not necessarily a satisfaction of the entire debt unless a new consideration accompanies it or it involves a compromise or an accord and satisfaction.

3. A receipt in full, even without protest, does not imply a settlement in regard to matters not included in the receipt of the voucher to which it is attached.

4. A receipt in full, even without protest, is not a satisfaction of unliquidated damages, not within the power of the Department to adjust or pay.

5. A protest made at the time of payment will prevent a receipt in full from operating as evidence of acceptance by the contractor of the settlement offered by the United States and usually will preserve his rights to determination of the points in controversy upon their merits.

6. A protest on items stated will be considered as an acceptance of all matters not named.

7. In the absence of a protest, very slight circumstances will lead to the conclusion that a receipt in full is intended as a full settlement of a claim.

8. If a claim is settled by a commission or other like tribunal, acceptance of the amount allowed may be taken, even with a protest, as an acceptance of a settlement offered by the United States and therefore a finality.

Practical Rules.—The result of this discussion makes very clear some practical rules for the guidance of contractors upon receipt of any payment where an item is in dispute.

1. When partial payments are made, in whole or in part, involving disputed items, written notice should be given to the officer making the payment at the time of payment that it is not accepted in full upon the disputed items.

2. Upon final payment notice should always be given, if any balances are still claimed by the contractor.

3. In giving such notice upon final payment, the better practice is to advise the officer making the payment in writing, before the voucher is signed that there are still unsettled balances and to ask leave to sign the voucher with a reservation upon its face of items in dispute. This request will almost uniformly be denied and the voucher may then be signed without interlineation. Upon signing the voucher the officer making the payment should be notified in writing and a duplicate sent to the highest officer approving the original contract, that the amount of the voucher is not received in full, but that the right is reserved to make further claim before the Treasury Department or the courts.

4. In drawing such notice every possible disputed item should appear, as the omission of any item of claim will be taken as a waiver of it. A general reservation of other objections should be added to permit the later inclusion of overlooked details.

(To be Continued.)

THE HEAVIEST RAILS that have ever been rolled, it is said, weigh 142 lb. per yard and are being used in a belt line railroad around Philadelphia.

Cleaning the Old Sand Water Filters at Hudson.

The slow-sand filter plant of the Hudson, N. Y., water works, the second plant of that type built in this country, has recently been thoroughly overhauled for the first time since it was put in service. Hudson is on the east bank of the Hudson River, about 130 miles from its mouth. The filter plant is on a hill 310 ft. above the river and 175 ft. above the central portion of the town. It formerly consisted of two open filter beds, one having an area of 0.25 acre and the other of 0.5 acre, and an open 3,000,000-gal. clear-water basin. The smaller filter and the clear-water basin were built in 1874 by Mr. J. B. G. Rand, and the larger filter was built in 1888. The water supply was formerly drawn from the Hudson River and pumped directly on the filters, no sedimentation basin having been built in the original plant.

The river was abandoned as a source of supply last summer on the completion of a pipe line, 13 miles long, which brings water by gravity from a catchment area of about 50 square miles back of the town. A 32,000,000-gal. storage reservoir is located 5 miles from the intake of the pipe line and affords a 45 days' supply. The pipe line ends at the filter plant above the town and the waterworks system is supplied from the clear-water basin, although it may also be connected directly with the pipe line. The plans and construction of the pipe line and the storage reservoir were fully described in The Engineering Record for April 1, 1905.

The catchment area from which the gravity supply is obtained is sparsely inhabited mountainous country, so the supply is comparatively free from dangerous contamination. The safest plan was considered, however, to filter the water and the old plant was reconstructed. The water carries practically no turbidity at most seasons of the year and for this reason it is expected that the filter plant can be operated at a somewhat higher rate than usual practice, if such a rate is necessary. The filtering materials were entirely removed from the smaller bed and after the latter had been thoroughly cleaned it was thrown in service for an additional clear-water basin. The materials were also removed from the larger bed and after being cleaned they were replaced, the large bed now being used to filter the entire supply.

Both of the old filters were constructed in practically the same manner. They had concrete bottoms and their sides were lined with a single course of rubble masonry on a slope of 1 to 1. The stones in this lining were somewhat larger than ordinary paving blocks and were laid in cement mortar from the bottom of the sides to the level of the filtering material; above that level they were laid loose. The filtering materials were 6 ft. deep. The lower 2 ft. consisted of rough quarry stones from 6 in. to 8 in. in their greatest dimension. Over these large stones was 6 in. of 2 to 4-in. broken stone; above that 6 in. of 1 to 2-in. gravel, then 6 in. of ½ to 1-in. gravel, 6 in. of ¼ to ½-in. gravel and 18 in. of coarse sand, with 6 in. of fine sand on top. The underdrains were 2x2 ft. in cross-section and had dry-stone sides, with flat stone-slab covers. The normal depth of water over this filtering material was 4 ft.

In cleaning the filters they were found to be exceedingly foul. The sand and stone were completely covered with dirty slime and a deposit of ill-smelling silt, 6 in. to 1 ft. deep, had accumulated the entire length of the underdrains. The silt contained a large amount of sawdust that had been deposited from the river water before the discharge of sawmill wastes into streams was prohibited in the State. The filtering materials from the old bed had also disintegrated badly, so they were largely wasted as they were removed from the filter. When the sand, gravel and stone were removed the bottom and the lining of the sides of the bed were then washed and scrubbed before the basin was used for filtered water storage.

The funds for carrying on the cleaning and overhauling of the filters and clear-water basin were limited to such an extent that it was decided to wash the sand, gravel and stone in the larger bed and then partially replace them. This could be done at considerably less cost than new materials could be obtained. The materials, except the large stone at the bottom, were first removed and stored on a bank back of the bed. An incline was built from near the center of the uphill side of the bed to a trestle erected parallel to and about 75 ft. from the latter. A 2-ft. track, with 12-lb. rails, was laid over the surface of the sand from the end of this incline. The different materials were taken out as far as practicable in layers and shoveled into 1-yd. Koppel cars, which were pushed by hand to the foot of the incline. A Lidgerwood hoisting engine then elevated the cars up the incline to a switchback connecting with the trestle. The latter was 15 ft. high and the various sizes of sand and gravel were dumped from it in separate piles as nearly as possible, in order to simplify the cleaning work.

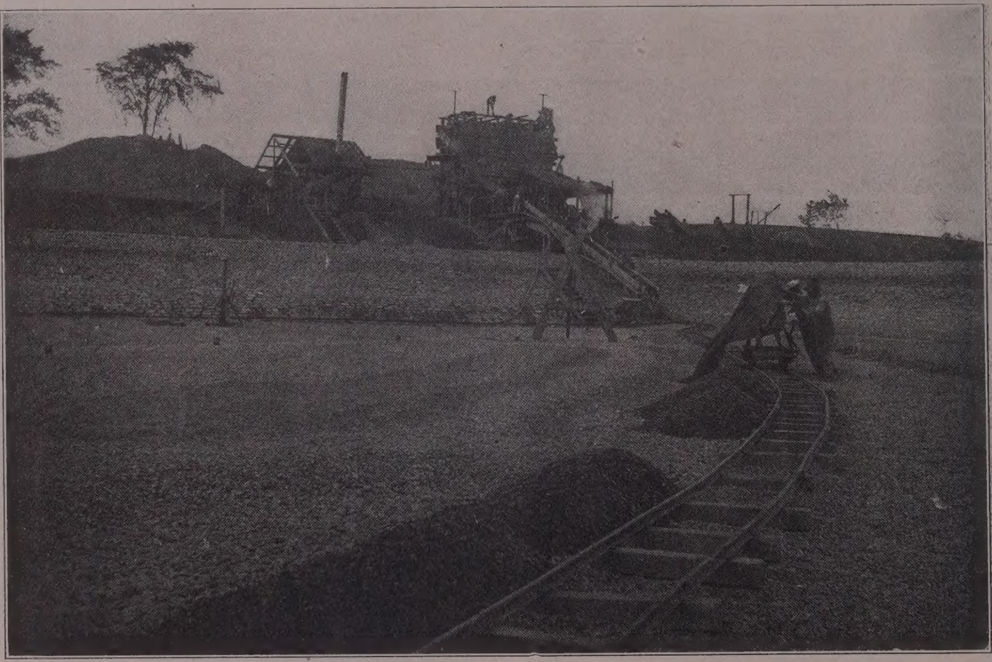
The underdrains were removed when everything had been taken out down to the 2 ft. of large stone, 12 in. of which was to be replaced. The cleaning of these stones was one of the most difficult parts of the work. They were heavily coated with slime which could be washed off only when struck directly by a stream from a hose. The water supply available from the gravity system at the time this portion of the work was in progress was limited, owing to the fact that the storage reservoir had not been completed and that the water in the creek from which the supply is directly obtained was at a low stage. When the old drains had been removed and lines of 12 and 18-in. vitrified-pipe main drains, with 6-in. laterals, were laid, just about enough large stone remained to replace the 12 in. desired in the new arrangement.

The large stones had to be thoroughly cleaned with the least amount of water necessary, since the supply was so limited. After considerable experimenting several large 1x10x3-ft. wooden tubs, mounted on legs, were built and each stone was scrubbed by hand with a wire brush. The tubs were placed in a row on the bottom of the bed, with 3 or 4 men at each tub, facing the pile of clean stone. The dirty stones were handed to these men by a man working in the pile of stones back of them that had not been washed. When a man at the tubs had cleaned a stone he threw it into the pile of clean stones back of him, attempting to place it so as to keep the pile approximately level; two or three men were required, however, to keep the layer of stone properly level and compact. The tubs were scrubbed out and refilled about 3 times every 10-hr. shift.

This method of cleaning the large stones cost about 70 cents a cubic yard, which is much less than the cost of new stone, and only a very small amount of wash water was required. Electric lights were placed over the bed and work was carried on by two 10-hr. shifts. The cleaning of the stones was completed in two weeks and as the remodeling of the filters could not be commenced until toward the close of the season, this was a great advantage, for the delay that would have been occasioned by waiting for the arrival of new materials might have prevented the completion of the work before cold weather.

After the 1-ft. layer of large stones was in place 4 in. of the 1 to 2-in. gravel, 4 in. of the ½ to 1-in., and 4 in. of the ¼ to ½-in. gravel was washed and placed over it in the bed. Water was abundant when this work was commenced and some of the larger sizes of gravel were washed with a stream from a hose. A plant for washing all of the gravel was set up soon afterward, however, on the bank between the trestle and the edge of the bed. The gravel was hauled in wheel-barrows from the storage piles to the boot of a bucket elevator which discharged into an inclined rotary screen at the top. The screen discharged in turn into 10-cu.-yd. wooden bins, one for each size of gravel. The bins were each connected by chutes to the feed of a 1-yd. Ransome concrete mixer mounted below and in front of them, the gravel feeding into the mixer by gravity.

The rotary screen consisted of a 2-in. steel shaft, 24 ft. long, carrying 2.5-ft. wheels with wide flat flanges. Heavy wire-screen cloth with different sized meshes was wrapped around these wheels. The latter were placed on 2-ft. centers, the width of the screen cloth, and the cloth bound around them with iron strips flanged at the ends. A 2½-in. hose supplied water to the mixer, as the regular 1-in. feed on the mixer could not furnish water fast enough. A sheet-steel chute led from the mixer down into the bed. The bottom of the first 20 ft. of this chute was perforated to allow the water carried over from the mixer to escape into troughs and be conducted away before entering the bed.



Arrangement of the Gravel Washer.

The end of the narrow-gauge track was placed under the lower end of the chute from the mixer. The washed gravel was discharged into 1-yd. Koppel cars on the track and hauled to the different parts of the bed. The replaced gravel was carried up in practically uniform layers and the track shifted by the men as required. The silt and mud were removed from the sand in a washer set up near the gravel washer at one corner of the bed. The sand washer consisted of a 10x3x 3-ft. wooden box, open at the top, and with water pipes in the bottom. A 4-in. transverse pipe was placed at one end, with three longitudinal perforated 2-in. pipes extending nearly the length of the box from it. The wash water was supplied by these pipes and was kept about 2½ ft. deep in the box. The dirty sand was dumped in at the top from wheel-barrows running on a platform. The dirty water was drawn off in transverse troughs with the tops of their sides set as weirs at the level of the water. The clean sand was drawn out at the opposite end of the box from the water supply pipe, through a small opening in the bottom covered with a slide. It was carried down to the bed in a trough, some of the clean water going on the bed with it.

The cost of cleaning the larger bed was $8,000; the cost of cleaning the other bed and the clear-water basin was $2,000. The labor charges for removing the sand and gravel from the bed and grading them roughly in the storage piles was 55 cents a cubic yard. The washing, screening and replacing of the sand and gravel cost 35 cents a cubic yard for labor. The plant charges amounted to about 25 cents a cubic yard, 6,000 cu. yd. of sand and gravel being handled. The total cost was thus about $1.15 a cubic yard. New materials would have cost $1.50 a cubic yard, unwashed and unscreened.

The new filter bed is 10 ft. above the two clear-water basins and will be supplied directly from the gravity supply pipe line. It will be operated at a rate of about 3,000,000 gal. per acre per day. The normal consumption in Hudson is 1,500,000 gal. a day and as the clear-water storage capacity is now 4,000,000 gal., the regular rate of filtration can usually be easily maintained.

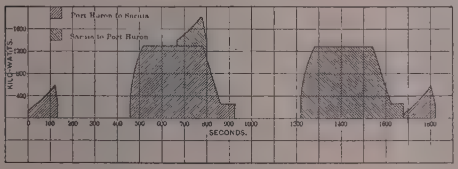
The reconstruction and cleaning of the filters was carried on by day labor under the direction of the Special Commission of Public Works of Hudson, Mr. H. K. Bishop, chief engineer, and Mr. C. C. Vermuele, of New York, consulting engineer. That commission also had the supervision of the design and construction of the gravity supply line and the storage reservoir.

The Locomotive Station of the Pennsylvania R. R. at which steam operation will cease and electric operation begin for handling trains under the Hudson River into New York, will be located at Harrison, N. J., according to announcements made this week. It is also proposed to build large yards here, relieving the Jersey City yards of their present congested condition. Harrison is essentially a part of Newark, being separated from it by a narrow river only, and by establishing the terminals there it is possible to secure abundant land and avoid the necessity of operating trains electrically over a drawbridge, as would be required were Newark proper made the point of change.

The Electric Locomotives for the St. Clair Tunnel.

The St. Clair tunnel between Port Huron, Mich., and Sarnia, Ont., is the connecting link between the Canadian and American divisions of the Grand Trunk Ry. system. It is a single-track tunnel 6,032 ft. long. The portion under the river has a length of 1,712 ft., and an eastward grade of 0.1 per cent. The 2,399-ft. ramp on the Michigan side and the 1,915-ft. ramp on the Ontario side have grades of 2 per cent. up to their respective portals, and these grades are continued up to the yards on each side of the river, the approach on the American side being 2,515 ft. long and that on the Canadian side 3,269 ft. The tracks through the American yard are 3,583 ft. long and those on the other side are 3,949 ft.; both are practically level and double-tracked to within about 300 ft. of their respective portals. The total distance from terminal to terminal that will be electrically equipped is about 19,348 ft.

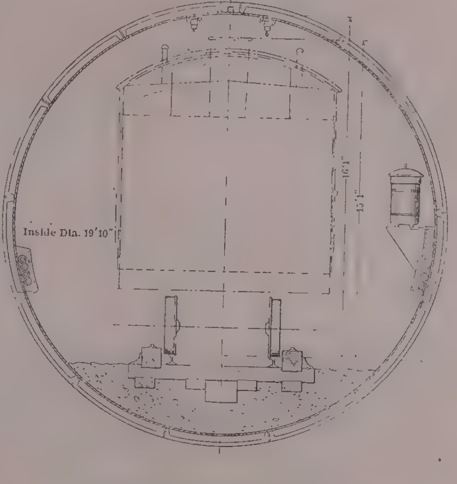
The operation of trains through this tunnel has long been unsatisfactory to the officers of the Grand Trunk Ry., and since several trainmen were suffocated in the tunnel some two years ago there has been a strong aversion to its use by steam locomotives. Special locomotives were constructed, fitted for burning anthracite coal so as to reduce the fumes and smoke given off to a minimum. They were designed to pull trains of about 820 tons, but climatic conditions at the tunnel keep the rails in such a state that the maximum load is probably about 750 tons as a rule. Much heavier trains than this are brought into the yards at each end of the tunnel, and it is accordingly necessary to divide them for transfer through the latter. The present maximum train of the Grand Trunk Ry. is 2,000 tons, which would require a drawbar pull of 100,000 lb. on the 2 per cent. grades of the tunnel and its approaches. This drawbar pull is much too great for general service, according to the railway officials, and it was accordingly decided to base the requirements for the electrical equipment on a pull of 50,000 lb.; this does not prevent handling heavier trains with a pusher and header locomotive if desired, or by any other practicable combination.



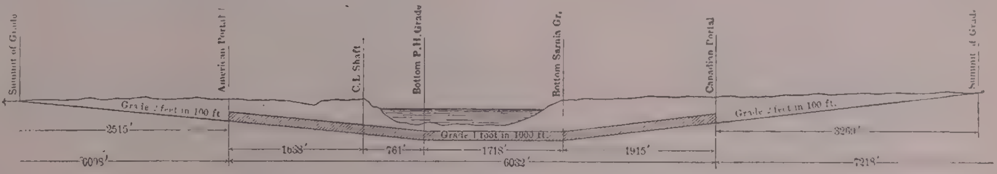
Power Station Requirements.

General Conditions.—The general problem of designing a system of electrical operation for the tunnel trains was assigned to Mr. B. J. Arnold. The conditions of operation are unusual, for the passage of the trains through the tunnel, coasting for a time and then imposing a rapidly increasing strain on the drawbar of the locomotive, will produce power station conditions which are extraordinary. Before reaching any decision concerning the proper equipment, he made studies of operation by both direct and single-phase current, in each case both with and without storage batteries. From the data secured in this manner he was convinced that use of single-phase equipment without storage batteries was the best solution of this particular problem. Some idea of the complication of conditions that will arise in the operation of the power station may be gathered from the fact that in case the power station is supplying power for traction, lighting and pumping at the same time the load on the generators will range from about 800 kw. during the seven or eight minutes the train is coasting to about 2,000 kw during the seven minutes it is on the up-grade. Such conditions were of material weight in the selection of the entire station equipment.

General plans and specifications were prepared by Mr. Arnold, fixing those details of the design which were definitely required and leaving considerable latitude in some other respects to the manufacturers invited to bid on the equipment. The general service conditions, which alone among the requirements are of general engineering interest at this time, were substantially as follows: The locomotive is to be coupled to its train of 1,000 tons on the level track at a point 1,200 ft. from the summit of the grade and accelerate this train up to a speed of 12 miles per hour in two minutes, when it will have reached the summit of the grade. It will continue to take current until the train is partially on the grade, when the current will be shut off and the train will coast down the 2 per cent. grade on the level portion of the track in the tunnel at a speed not exceeding 25 miles per hour. As soon as the train is on the level track in the tunnel the locomotive will begin taking current, so that by the time it has reached the foot of the ascending grade it will have taken the slack out of the drawbars in the train. From this point to the top of the grade it shall be capable of hauling the train at the rate of 10 miles per hour until the entire train is off the grade and on the level track, when it will gradually accelerate the speed to 18 miles per hour. The locomotive must be capable of exerting a maximum effort of 50,000 lb. in addition to propelling itself for a period of 5 minutes, and in addition to the energy required to accelerate the train at the starting point and run with it into the terminal yard. After coming to a stop in the terminal yard it will uncouple and run immediately back to a point 1,200 ft. from the summit, where it will couple to another train and be ready to start through the tunnel in the opposite direction as soon as the next train clears the tunnel block, thus making a run of the above character through the tunnel every 30 minutes. The locomotive shall also be capable of starting a 1,000-ton train from rest on the 2 per cent. grade and hauling it over the summit.



Section of St Clair Tunnel.



Profile of the St. Clair Tunnel to be Operated Electrically.

Electric Locomotive.—The single-phase electric locomotive unit, of which six will be furnished, will weigh approximately 62 tons, and will develop a drawbar pull of 25,000 lb. on a 2 per cent. grade at a speed of 10 miles per hour. It is of the rigid-frame type with driving axle boxes held in the same frame that contains the draft gear. It will be mounted on three pairs of driving wheels which will sustain the entire weight, distributed by equalizer bars similar to those used in steam locomotive practice, will have an outside frame supported on semi-elliptical springs, and will be equipped with Westinghouse friction draft gear, M. C. B. automatic couplings, air sanding apparatus, and bumper steps, front and back. The cab will be of sheet steel mounted on a framework of iron which supports both walls and roof.

The principal dimensions will be approximately as follows: Length over end sills, 27 ft. 9 in.; rigid wheel base, 12 ft.; width over all, 9 ft. 6 in.; height from top of rail to top of cab, 12 ft. 6 in.; diameter of driving wheels, 62 in.

The operating apparatus will be arranged along the sides of the cab, leaving a free passageway 3½ ft. wide the entire length. The cab will be lighted and heated by electricity, and arrangements are made to screen the instrument lights while the locomotive is running.

Westinghouse combination automatic and straight air and American driver brakes will be used. The air supply will be provided by a two-cylinder, motor-driven air compressor, having, with a 5-in. stroke and a speed of 190 r.p.m., a capacity of 45 cu. ft. of air per minute. Air reservoirs, signal outfits, whistle, bell with pneumatic ringers, automatic pump governor, tools, instruments, gauges, headlights, push poles and other details complete the auxiliary equipment.

Motors.—A motor will be geared to each axle, giving each unit an aggregate rated capacity of 750 h.-p. They are of the Westinghouse single-phase, alternating-current, series-wound, compensating type, whose successful development was first publicly announced in the notable paper read by Mr. B. G. Lamme before the American Institute of Electrical Engineers on Sept. 26, 1902. They are of the same general character as the motors selected by the New York, New Haven & Hartford R. R. Co. for the operation of its line between New Haven and New York. Each motor will weigh complete approximately 14,500 lb., the armature weighing approximately 5,600 lb.

The motor frame consists of a steel cylinder cast in one piece and enclosed at the end by brackets of the same material, which carry the bearings and oil reservoirs. The suspension noses and safety lugs form a part of the main casting. Seats for the axle bearings are cast solid with the frame. All bearings are of phosphor-bronze lined with babbitt and are divided into two parts. They are of exceptionally large dimensions, are arranged for oil waste lubrication, and are provided with large openings on the low pressure side, giving a thorough lubrication of the entire bearing surface. Oil is fed into the reservoirs through openings separate from the waste pockets and therefore reaches the waste from below and is thoroughly filtered before entering the bearing.

The motors are swung between the locomotive frame and the driving axles by a flexible nose suspension from two hangers supported by a truck transom and passing through heavy lugs with helical springs above and below the lug. The motors are held to the axle by means of caps which are split at an angle of 35 deg. with the perpendicular, so that the greater part of the weight is borne by solid projections from the motor frame which extend over the axle rather than by the cap bolts. Large openings above and below provide access to the commutator and brush holders.

Within the cylinder of the motor frame there is built up a core of soft steel punchings, forming a completely laminated field. The punchings are dovetailed into the frame and clamped between end rings of cast steel. The field coils are wound with copper strap insulated between turns and about the coils by mica and finished by taping and dipping, and are impregnated in the best grade of varnishes, providing a sealed coil which can withstand the most severe internal heat, and is practically indestructible under the usual conditions of heavy railway service.

In addition to the main coils the field carries a neutralizing winding which consists of copper bars placed in slots in the pole faces and joined at the ends by connectors of copper strap, so as to form one continuous winding which is connected in series with the main field winding and with the armature circuit. The magnetizing effect of this auxiliary winding is directly opposite to and neutralizes that of the armature winding, thus eliminating the effect of armature reaction and improving commutation and power factor. The main coils can be easily removed without disturbing the auxiliary winding.

The armature cores are formed of slotted soft steel punchings built up upon a spider and keyed in place. The spider is forced upon the shaft with heavy pressure and secured by a steel key. Coils of copper strap are embedded in the slots and joined to form a closed multi-circuit winding which is cross-connected, like the multi-circuit winding of a direct-current generator. The basis of the insulation is mica. A preventive winding is connected between the commutator and the main coils, introducing a preventive action which is effective only when the coil is passing under the brush.

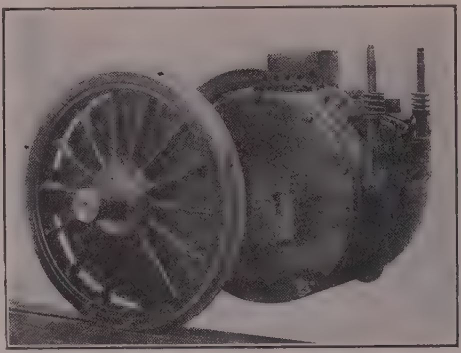
During operation a forced circulation of air supplied by motor-driven blowers enters at the rear, distributes itself thoroughly throughout the motor and escapes through the perforated cover over the commutator. This system of forced ventilation of both motors and auxiliary apparatus forms one of the most interesting innovations in electric railway construction. It secures a maximum output from a given weight of material, and a high ratio of continuous output to the one-hour motor rating common in railway practice. It also provides effective ventilation while the locomotive is not in operation as the blower may be driven while the locomotive is standing at the station or the end of the line. Motors ventilated in this manner are enclosed and are thereby protected from internal damage by dirt and water and from mechanical injury.

These motors are wound for 240 volts and 25 cycles per second and have a nominal rating of 250 h.-p. each, on the basis of usual electric railway practice.

System of Control.—The essential elements of the control equipment include the collecting devices, the auto-transformers, the unit switches, the preventive coils, the reverser and the master controllers. A multiple-unit system of control is provided, with pneumatically operated switches and circuit-breakers, low-voltage control circuit, and other characteristics standard in Westinghouse practice. Any unit may be controlled from either end, and two or more units may be coupled together and operated from a single cab and by a single crew. The tractive effort which can be readily applied to a single train is therefore limited only by the number of units available, and the hauling power is limited only by the mechanical strength of the coupling between locomotive and cars. A control circuit is carried from one unit to the next by means of connecting sockets and jumpers in the usual manner.

Speed control of the driving motors is secured by variation of the voltage at the motors, obtained by means of taps taken from the winding of the auto-transformer which receives current from the trolley at 3,000 volts and reduces it to 240 volts or lower, according to the tap employed. These taps are connected to unit switches from which current is led through the preventive coils to the motors. Four unit switches serve to reverse the field of each motor.

The unit switches are of standard Westinghouse design and are, in effect, pneumatically operated circuit breakers of great power and reliability. The mechanism is such that a rolling and sliding contact is obtained when the switch closes and opens. The arc is broken at the tips, leaving the contact surfaces smooth and unscarred. Each unit has a magnetic blow-out coil with laminated core. The switch cylinders are controlled by magnetically operated valves, current for which is obtained from a 50-volt tap from the auto-transformer. The sequence of operation is governed by the master controller in conjunction with a system of interlocks which prevents short-circuit of the steps between taps from the auto-transformer or improper operation of the controlling mechanism. At any running point four controlling switches are closed. Through the preventive coils approximately the same amount of current is drawn from each of these switches and the leads to which they are connected. To change to a higher voltage on the motors, the master controller is moved to the next notch, opening the last switch of the group that is closed and closing the switch next higher, with the result that the motor voltage is shifted up one step. By this arrangement the voltage at the motor will be completely under control of the locomotive driver and may be varied up and down at will without opening more than one-quarter of the load current. Small switches in the circuits to the magnets of the reversing switches will enable any motor or combination of motors to be cut out without disturbing the others.



Motor of St. Clair Locomotive.

Every one of the seventeen controlling connections provides an efficient running point. This number is ample to prevent any slipping of the driving wheels due to increase of current from one notch to another. Whether empty or heavily loaded, operated in single or multiple units, the torque and drawbar pull may be gradually applied and the locomotive started without jar.

Collecting Devices and Overhead Construction.—Each locomotive unit will be equipped with a pneumatically operated pantagraph trolley to collect current from the overhead lines outside the tunnel and throughout the yards. The proportions of the pantagraph will be such that, when extended, it will make contact with the trolley wire 22 ft. above the rail, and, when closed down, the contact shoe will not extend more than 18 in. above the roof of the locomotive. The pantagraph will have a broad base and will be constructed of light and stiff material.

A No. 0000 grooved overhead trolley wire will be suspended from a single ⅝-in. high strength, double galvanized, steel strand, messenger cable by hangers of varying length in such a manner that the trolley wire will be approximately horizontal. The messenger cable will be swung from structural iron bridges located throughout the yard and of suitable length to span the proper number of tracks. There will also be a small section of track equipped with a trolley line swung by catenary suspension from bracket arms which are supported on lattice-work poles.

Current Supply.—For the operation of the electric locomotives a complete power plant will be installed by the St. Clair Tunnel Company, including two 1,250-kw., 3,300-volt, three-phase, 25-cycle, 1,500 r.p.m., rotating field, Westinghouse steam turbine units with the necessary complement of switchboards, exciters, lightning protective apparatus, etc. This station will also supply current to light the buildings, yards and tunnel, to operate motor-driven centrifugal and triplex pumps which drain the tunnel and approaches and operate the sewage systems, to run motors in the round houses and for other purposes.

The Failure of a Canal Embankment.

On Dec. 26 a canal bank gave way at North Chelmsford which deserves a brief notice. The canal runs from a pond covering about 75 acres to a number of mills, and is about 20 ft. wide and half a mile long. Its side bank is characteristic of many in that section, being composed of sand which has become water-tight through the silt deposited in its pores. This construction, at variance with the accepted practice of to-day, was common half a century or more ago in New Hampshire and Massachusetts. The old Middlesex canal had banks of loose gravel which must have allowed large quantities of water to percolate through them before they became silted up. The late Albert F. Noyes stated that in making such a canal embankment it was best to have the material slightly damp but not wet, and to use no water while rolling the layers; this is the only technical statement concerning them that The Engineering Record has seen.

Such a method of constructing a canal or low dam in a section where animals are likely to burrow into the material and thus open a channel for a wash-out is manifestly not to be adopted if a better construction can be chosen. The accident at this particular canal, however, was not due to any defect in the embankment's structure or to the burrowing of animals, but was caused by carelessneess. For many years the ice that formed on the pond was harvested by an ice company. In order to get it out of the pond and across the canal to the fields on the other side, where it was loaded, a runway was cut in the embankment. This was above the level of high-water in the pond, so far as was known at the time. On Christmas, however, the water began to rise and very soon the level in the canal rose to the runway, through which the water began to pour. It was only a short time before this overflow cut a crevasse in the embankment, and put the canal out of business for some time while repairs were being made.

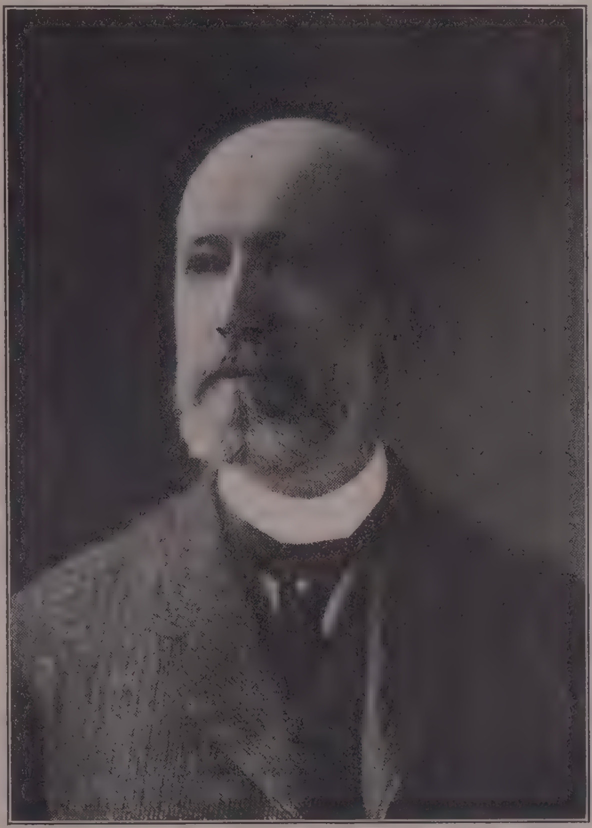
The accident is interesting as an instance of a washout which was due to carelessness in cutting into a water-resisting embankment. Such an act is inexcusable with any kind of a bank, if it can possibly be avoided.

Frederic Pike Stearns, Pres. Am. Soc. C. E.

At the annual meeting of the American Society of Civil Engineers this week Mr. Frederic P. Stearns was elected president, an honor that many members have felt has been a long time due him. His election is particularly interesting in that it raises to the highest position in the gift of American civil engineers a gentleman whose family has been identified with the country from its earliest days, for he is a direct descendant of Isaac Stearns, who came to Massachusetts Bay with Governor Winthrop and settled in Watertown, Mass., in 1630. Mr. Stearns was born in Calais, Me., on Nov. 11, 1851, and studied in the schools of this city until he was about 18 years old, when he moved to Boston. There he joined the staff of the city engineer and entered upon a connection of about seventeen years with that municipality.

During the first years of his work he followed a carefully planned course of technical study, as was the customary procedure of most ambitious young engineers at that time. The city has always been fortunate in having in its most responsible engineering offices men of the highest distinction, and it is not exaggeration to say that association with them has been of no small educational value. For eight years ending 1880 Mr. Stearns was engaged on the studies, plans and construction of the works for bringing an additional water supply into Boston from the Sudbury River, and during their construction he held the position of division engineer. It was during this period, when he was 26 years old, that he suggested the hydraulic experiments which he afterward carried out in association with Mr. Alphonse Fteley; these were fully described by them in a paper entitled "Description of Some Experiments on the Flow of Water Made during the Construction of Works for Conveying the Water of Sudbury River to Boston," published by the American Society of Civil Engineers in 1882 and awarded its Norman medal. Although these experiments called for a great deal of hard work outside the regular duties of his position, Mr. Stearns once stated that he never regretted the labor spent on them, as the training was of special value and he learned by experience that the publication of work that is carefully done is of advantage to a young engineer.

In 1880 he was transferred from the waterworks of the city, the Sudbury division being completed and in service, to the main drainage works, which were then under construction, and was appointed division engineer in charge of the tunnel under Dorchester Bay and the reservoir and other outlet works. The main drainage works were the most important sewerage system undertaken in this country up to that time. In 1875 E. S. Chesbrough, Moses Lane and Charles F. Folsom initiated the work by recommending the construction of intercepting sewers and pumping stations on both sides of the Charles River. The next year the portion of the project for the district south of the river was adopted and surveys undertaken. In 1877 the appropriations for construction were passed and work was begun, Mr. Joseph P. Davis being at that time the city engineer. The works included intercepting sewers along the margins of the city to receive the discharge from the existing sewers, a main sewer running from the intercepting sewers to a pumping station at the water front, a tunnel under Dorchester Bay, forming the greater part of the outfall sewer from the pumping station to Moon Island, where a reservoir was built in which to store the sewage until it could be discharged during the first two hours of the ebb tide. The tunnel on which Mr. Stearns was stationed is nearly horizontal and about 140 ft. below low water level. It passes through beds of clay, slate and conglomerate, generally hard and reasonably uniform, but penetrated by occasional seams yielding a moderate amount of water. There are three shafts on the tunnel, which has a diameter of 7½ ft. inside the 12-in. brick lining and is 6,089 ft. long between the end shafts. A full description of the main drainage works was printed in this journal during the first half of 1884, to which the reader is referred for further information. Upon their completion Mr. Stearns was placed in charge of their operation and maintenance, as executive engineer.



Frederic P Stearns

In 1886 the Legislature of Massachusetts took a step which had very important results. The so-called State Board of Health, Lunacy and Charity, created in 1879, had never given satisfaction and had been under a cloud from the outset, owing to the strong and very natural suspicions that prevailed concerning the motives for its organization. In 1886 a new State Board of Health was created on substantially the same basis, but with rather enlarged duties, as the original body of this nature organized in 1869. One of the members was Mr. Hiram F. Mills, and through his energy the engineering features of the board's work were given due weight in its program. Mr. Joseph P. Davis was appointed its consulting engineer and Mr. Stearns was appointed chief engineer, with Mr. X. H. Goodnough, the present chief engineer, as his assistant. For a time the work was largely in the nature of examining projects for water and sewer systems which, under the Massachusetts laws, must receive the sanction of the board before work can be done on them. In determining the merits of projects the board early adopted a policy which it stated briefly in 1887 as follows: "We are more convinced from day to day of the necessity of some control of the questions of water supply and drainage, so removed from individual towns and cities as to be able to consider dispassionately the interests of all parties who may be affected. With a city or town, the decision must necessarily be a selfish one." Mr. Stearns found time, in the course of his regular duties, to prepare a number of important papers on subjects connected with the storage of water, which were published by the board in its annual reports. One of these, on the available run-off from watersheds, has proved among the most useful contributions from American sources to the literature of water supply.

In the course of his work as engineer of the State Board of Health, Mr. Stearns made a very thorough investigation of the problems involved in a main sewerage system for the Mystic and Charles River valleys and later made an investigation and report on a water supply for the metropolitan district of Boston and vicinity. A little later he also acted as the chief engineer of a board, embracing the members of the State Board of Health and the Metropolitan Park Commission, on the improvement of the Charles River. He recommended the construction of a dam creating a fresh-water basin in which the water would remain at a fairly constant level. All of these works are now in progress in substantial accord with the recommendations made by him. In 1895 he was appointed chief engineer of the Metropolitan Water Board, organized to build the works recommended by one of these reports, and on the consolidation of the State water and sewerage organizations in the Metropolitan Water and Sewerage Board he was appointed its chief engineer, so that he is now in direct charge of the engineering work on two of the important projects he originally planned. The third work, the Charles River dam, is under the direction of the Charles River Basin Commission, with which he is connected as consulting engineer.

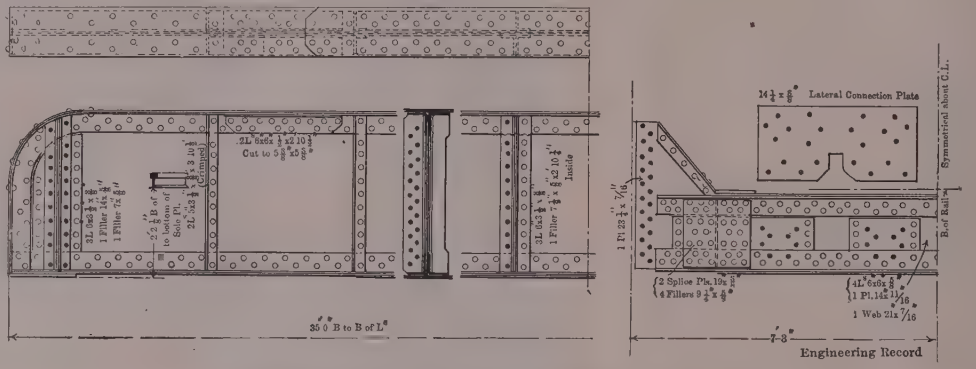
In addition to these main features of Mr. Stearns' professional career he has been a member of several important engineering boards. In connection with Messrs. Rudolph Hering and Samuel M. Gray he planned a sewerage system for the District of Columbia, which is now approaching completion. He was consulted by the first Rapid Transit Commission of Boston, in 1892. He is associated with Messrs. Freeman and Burr as consulting engineer to the Board of Water Supply of New York, which will construct the enormous works for that city. He is associated with Messrs. Hering and Gray on the board of consulting engineers of the Baltimore Sewerage Commission, which is now working out plans for the collection and disposal of the sewage of this city. He is also a member of the board of advisory engineers of the Isthmian Canal Commission. At its last Commencement Harvard University gave him the degree of Master of Arts.

Standard Plate Girders on the Chicago, Milwaukee & St. Paul Ry.

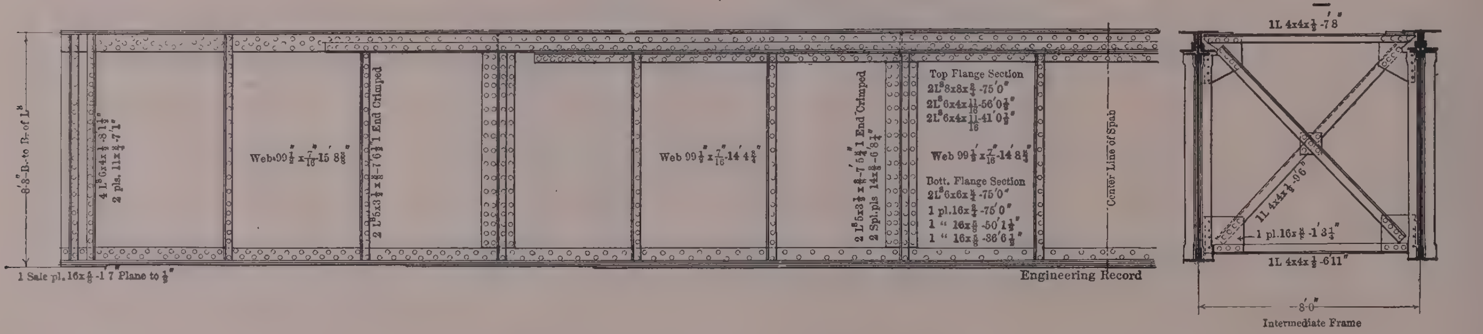
Shallow floor through plate girder bridges of spans up to 100 ft. on the Chicago, Milwaukee & St. Paul Ry. have girders of a standard design corresponding in detail and general dimension to the 35-ft. span Standard C3 type, of which an illustration is here given. It is made entirely of soft steel with rivet holes punched ¾ in. diameter and reamed to 15/16, those for the floorbeam connections being reamed with iron templates 1 in. thick.

The girder has a single full-length 46x⅜-in. web plate and is cambered ¼ in. by a slight displacement of the templates when the steel is laid out, thus easily giving the required camber to the vertical legs of the flange angles.

Care is taken to space the top and bottom flange angles ½ in. farther apart, back to back than the width of the web plate, so that there is a ¼ in. clearance between the edge of the web plate and the flange cover plates. In intermediate span girders the top and bottom flanges have single-piece angles and cover plates. The upper corners of the girder are square except at the abutment ends, where they are rounded as shown in the part elevation. At the square ends the end web stiffener angles are of the same size as the intermediate web stiffeners but are set back about 3 in. clear of the end of the web. The intermediate web stiffener angles are crimped except at floorbeam connections, where they have fillers, and one angle of each pair is field-riveted to both girder and floorbeam, the other angle being shop-riveted to the girder and field-riveted to the floorbeam. The span is divided into three 10-ft. 11-in. panels by the floorbeams, which for this type of structure are very shallow and heavy.



General Design of a C3 Type of Shallow Floor Bridge.



Standard Seventy-Five Foot Deck Girder Span, Type A4.

The panels between floorbeams are X-braced by 6x⅜-in. diagonal bars with four rivets at each end to ⅜ in. connection plates notched to clear the web stiffener angles and field-riveted to the bottom flanges of the floorbeams. They also have two field rivets at all intersections with each other and with the lower flanges of the stringers. There are two lines of 15-in. 60-lb. I-beam stringers for each rail. Track ties 8x8-in. by 10 ft. long, 12 in. apart on centers are carried on the top flanges of the stringers and are bolted to the outer lines of stringers only. There are two guard rails and a guard angle for each rail, arranged as shown for type C4, but spaced somewhat differently. The end ties are carried over the bridge seats by stringer brackets made with short sections of 15-in. I-beams.

The standard type C4 single-track through 65-ft. span girder differs from the span already described chiefly in the floor construction, which has deeper floorbeams and only two lines of stringers, which are riveted plate girders 12 ft. 6½ in. long with a 22½x½-in. web and pairs of 6x4x11/16 in. flange angles without cover plates. Each panel is X-braced with 4x4x⅜-in. angles, one of which is continuous and the other is cut to clear it at the intersection and spliced with a horizontal bottom flange plate. Short reversed angles connect the vertical flanges of the diagonals to the bottom flanges of the stringers, and care is taken to develop the strength of both flanges of the diagonals by short angle clips riveted to the vertical flanges at all connections.

The floorbeams have a 38¾x½-in. web and pairs of 6x4x11/16-in. flange angles with cover plates. The thickness of the web is made uniform throughout so as to avoid splicing the ½-in. end sections to thinner center sections. Their end gusset plates and girder connections correspond to those of the 35-ft. span, except that the web splice plates are extended to increase the bearings of rivets in the stringer connections. The web plate is made in lengths of 21 and 22 ft. spliced with ¼-in. clearance at the joints which have four vertical rows of rivets through a pair of 13¼x⅜-in. cover plates. The sole plates take bearing on webbed cast-iron pedestals 10 in. high with 16x19-in. tops and 25x30-in. bases, seated on sheet lead. The holes in the girder flanges are slotted at both ends of the girder so that both ends can slide on the pedestals. Where the corners of the girders are rounded and the top chord angles are continued vertically to the bottom chord angles, the ends of the bottom flange angles are fitted against the end cover plate and the lower end of the top flange angles are fitted against the bottom flange angles.

Standard type A4 for long span deck girders is illustrated by the 75-ft. single-track span here shown in part elevation. The most notable feature is the special detail of heavy top flange section which has been adopted by the railway company several years ago. It is without web or cover reinforcement plates and is composed entirely of angles, giving maximum compressive stiffness and arranged to leave the upper surface of the flange flush throughout to receive the track ties without framing or cutting to clear rivet heads. The double line on the upper side of the top angle looks, in elevation, like a cover plate, but is really the elevation of the upper edge of the web plate which in this type of girder is specified to project ¾ in. above the backs of the flange angles. The ties are easily notched with transverse saw cuts to engage it and are thus secured against lateral displacement. The same device is applied to all plate girder floor stringers.

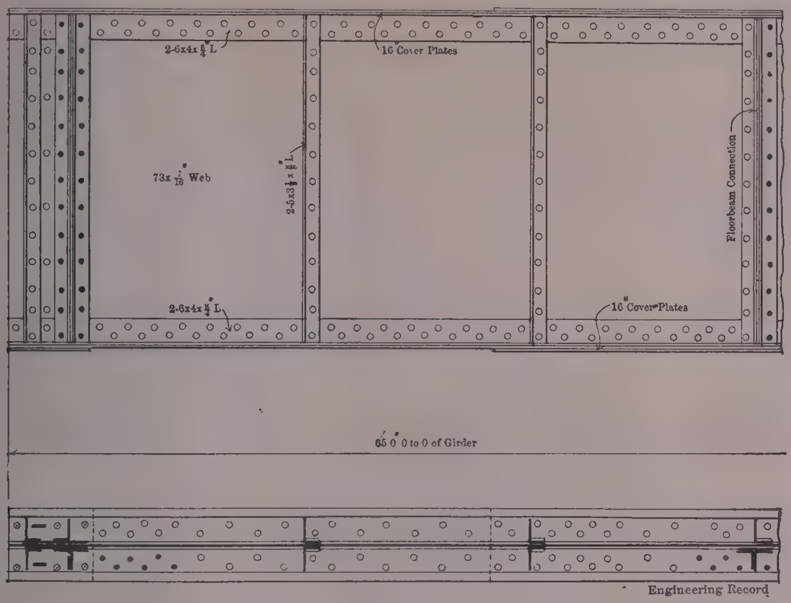
The span is divided into panels of about 6½ ft. by transverse sway frames like the one shown in the cross section, and by the two end frames which are similar but have 6x4x½-in. diagonal angles, and by transverse angle struts between the sway frames. The upper heads of the rivets connecting these frames to the top flange angles of the girder are countersunk so as to present no obstruction for the ties. Every panel of the top and bottom flange is braced by a single lateral angle of 4x4 in. and 6x6 in. maximum size in bottom and top systems respectively.

The 8x12-in. ties 12 ft. long and 12 in. apart on centers are secured at each end with a bolt and a lug-washer to the top flange of the girder, as shown in the floor detail. The pieces of 4x8-in. inner guard timbers are bolted at each end and in the center, and are spiked to all the intermediate ties and spliced at joints. The 6x8-in. outer guard timbers are notched over the ties, bolted to every third tie and spiked to the intermediate ties. A clearance of ¼ in. is left between the 6x4x½-in. guard angles and they are bolted to every third tie. These fastenings are the same for the floors in types C3 and C4.

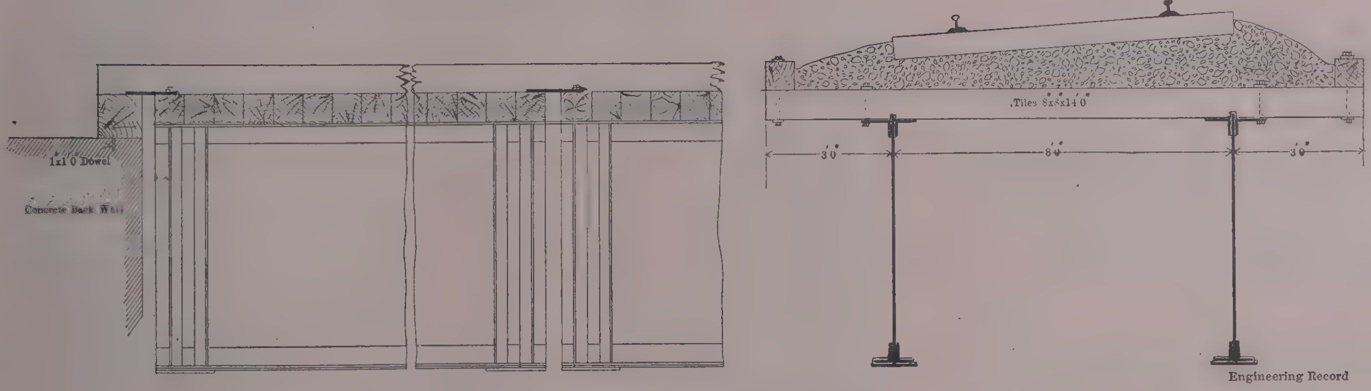
The girders are proportioned for a dead load consisting of the steel weight of the span plus a track weight of 450 lb. per linear foot, and for a live load consisting of two consolidation locomotives coupled, each with 50,000 lb. on each of four axles, 5 ft. apart, as given in Cooper's class E50, or for a special load of 130,000 lb. on two axles, 7 ft. apart, both loads being followed by a train load of 5,000 lb. per foot except in ore-carrying lines, where the train load is increased to 7,000 lb. The maximum unit stresses allowed are 8,000 lb. for riveted and I-beam stringer flanges, 8,500 lb. for net section of bottom flanges of the floorbeams. The allowed unit stress on the net section of the bottom flange of main girders varies uniformly from 8,000 lb. for 20-ft. spans, to 9,000 lb. for 100-ft. spans.

Standard spans up to 30 ft. which require a very shallow floor are made as shown in the part cross-section of type E, with simple through girders without flange cover plates. Two girders about 3 ft. apart are provided for each rail and carry it on 8x12-in. ties 13 in. apart on centers which have their ends fitted to bear against the girder webs. The ties rest on continuous 3x4-in. shelf angles riveted to the girder webs, with their horizontal flanges reinforced by vertical web-stiffener angles about 2 ft. apart. Guard timbers 4x5 in. are fitted between the ties and the top flanges of the girders and are toenailed to the former and spiked to the wall plates at abutments and piers. There is no lateral or sway bracing for spans of 25 ft. or less, and the girders for each rail are connected only by the track ties and bolts. The adjacent girders of the two pairs are spaced about 1 ft. 8½ in. apart and are connected by vertical transverse diaphragm plates riveted to the web stiffener angles about 6 ft. apart. Nailing strips are bolted to the upper edges of the diaphragms and to them are spiked the center 2x6-in. timber.

Where the extreme minimum of depth is necessary in shallow floors they are sometimes made, up to 12-ft. spans, with the 8x12-in. ties seated on the horizontal legs of the lower flanges of two plate girders for each rail. The timbers are arranged as in type E, and the girders are seated on cast iron pedestals with an H-shaped cross-section.



Fixed End of Sixty-Five Foot Span, Type C4.



Standard Ballast Floor for Deck Girders, Chicago, Milwaukee & St. Paul Ry.

The standard ballast floor for deck plate girder spans is made with 8x8-in.x14-ft. long leaf or loblolly pine ties laid close and every fourth tie bolted to the girders. Similar timbers bolted to the ends of the ties at intervals of 4 ft. retain the ballast in which the cross ties are bedded in any required position. All timber, except track ties, is treated, after framing, with 12 lb. per cubic foot of creosote oil, and all holes bored in the field are treated with hot creosote oil. The clearance between the ends of adjacent spans and between the end of a span and the abutment wall plate is covered by a horizontal steel apron plate spiked to one tie only and free to slide back and forth at the opposite edge.

The shop drawings of all bridges are made in the office of the bridge engineer, so that in some respects the specifications do not need to be so specific as if intended to govern outside designers, but the work is much facilitated and uniformity is insured by very complete draftsmen's rules, tables and standard details, which save a large amount of repetition in routine work. All tracings are made to one of two standard sizes, 1 ft. 11½x2ft. 10½ in. or 8½x14 in. and the riveting, clearances, dimensioning, arrangement of figures, notes, titles and other general features of the drawings are carefully specified. There are tables for the values of shop and field rivets for general work, flanges and floor system, lengths of field rivets and sizes of their heads, pitch, gauge and stagger of rivets, multiples of pitch for rivet spacing, end shears, maximum bending moments and maximum floorbeam reactions for one rail under Cooper's E50 loading. Standard details are also provided for the ties, guard rails and timbers in different types of floors, for pedestals, shoes, bolsters, rollers and bed plates, and diagrams are given of typical abutments with dimensions varied for different conditions. All designs and construction are under the direction of Mr. C. F. Loweth, engineer and superintendent of bridges and buildings, by whom most of the present plate girder standards have been prepared or modified.

Electrified Suburban Service is now afforded on the Paris-Juvisy section of the Orleans Ry. Some time ago the company introduced electric traction on its underground extension from the Quai d'Austerlitz to the Quai d'Orsay stations, about 2.6 miles long. The line to Juvisy is 11.8 miles long, and is operated like the other with direct-current locomotives.

The Protection of Small Harbors on Lake Michigan.

Last May, Lieut-Col. Wm. H. Bixby, Maj. Lansing H. Beach and Maj. D. DuB. Gaillard, Corps of Engineers, U S. A., were appointed a special board to inquire into the effect of wave action as injuriously affecting the harbors at Ludington, Manitowoc, Two Rivers, Racine, Kenosha and Sheboygan and to suggest a plan of resisting this action. The report of the board has just been made public, and from it the following notes have been taken:

Lake Michigan.—The length of Lake Michigan from the north end to the south end on a right line is about 307 miles; its average breadth is about 67 miles; the maximum depth is 870 ft.; the area of its water surface is 22,400 square miles; the mean surface elevation above mean tide at New York City is 581.35 ft.; the average date of the opening of navigation at the Straits of Mackinac is April 17, and that of the closing of navigation is Jan. 9; the level of the lake surface varies considerably from time to time; the lowest stage is from 1.5 ft. to 2 ft. below mean lake level, and obtains, with slight change, from early in November to April; the high stage usually obtains from the end of June to the middle of August. The east shore is generally composed of fine sand, the grains being so small as to be easily blown by the wind, and large quantities are moved by severe on-shore winds and storms, forming on this coast high dunes upon the front of a gently sloping shore. Such harbors as existed before improvements by the United States were in the mouth of creeks or small rivers, or the outlets from the small lakes near the Lake Michigan shore. At many of them sufficient depths for large vessels existed within the shore line and in the main lake just outside, but the entrances were obstructed by extensive bars formed partly by the sand thrown up by storm waves or blown from the banks into the streams and carried down by the current and partly by the sediment brought down from the upper watersheds. During the stormy season, when the harbors were most needed for shelter, the bars increased in height and extent, and although some were cut down by scour during the freshet period, they rendered the channels shifting and uncertain at all times.

The west shore is also mainly of sand, usually a trifle less fine than on the east shore; it shows many miles of steep bluffs, 50 ft. or more in height, due to the general westerly retreat of the shore under wave action. Most of the rivers flowing into Lake Michigan from the west are small and unimportant.

The harbors along the western shore of the lake are generally located at the mouths of rivers, the works of improvement consisting of two approximately parallel piers extending into the lake and protecting a dredged channel. As a result of the improvements made and maintained by the United States, all of the important harbors on the west shore of the lake are now accessible to vessels drawing from 18 to 20 ft. The rivers being generally small, and draining comparatively limited areas, carry down slight quantities of material, and therefore cause little silting up of the channels.

While dredging for the maintenance of all the artificial channels is necessary, usually on account of sand washed in from the lake, there is a marked difference between the quantity of dredging required at harbors situated only a few miles apart, dredging as a rule being less where the number of vessels entering and leaving is greater. It is the littoral drift of sand due to storms and currents, rather than material brought down by the rivers, that tends to obstruct the channel entrances. South of Manitowoc the drift is reported as generally to the southward; north of Manitowoc, while not so well defined, it is reported as generally to the northward.

Waves.—The Board has been unable to obtain any recorded measurements of the lengths, heights or velocities of storm waves on Lake Michigan, but from inquiries of employees of the Light-House Department, captains of life-saving stations, masters of vessels, etc., it would appear that the estimated height of the maximum storm waves at the various harbors visited varies from about 10 to 15 ft. measured from hollow to crest, and from about 7 to 10 ft. measured above average mean water level. During severe storms these waves roll into the harbor, and when there is no interior basin in which to expand, run up the bulkheaded and gradually narrowing river channel, causing in some cases serious inconvenience to vessels lying alongside the docks.

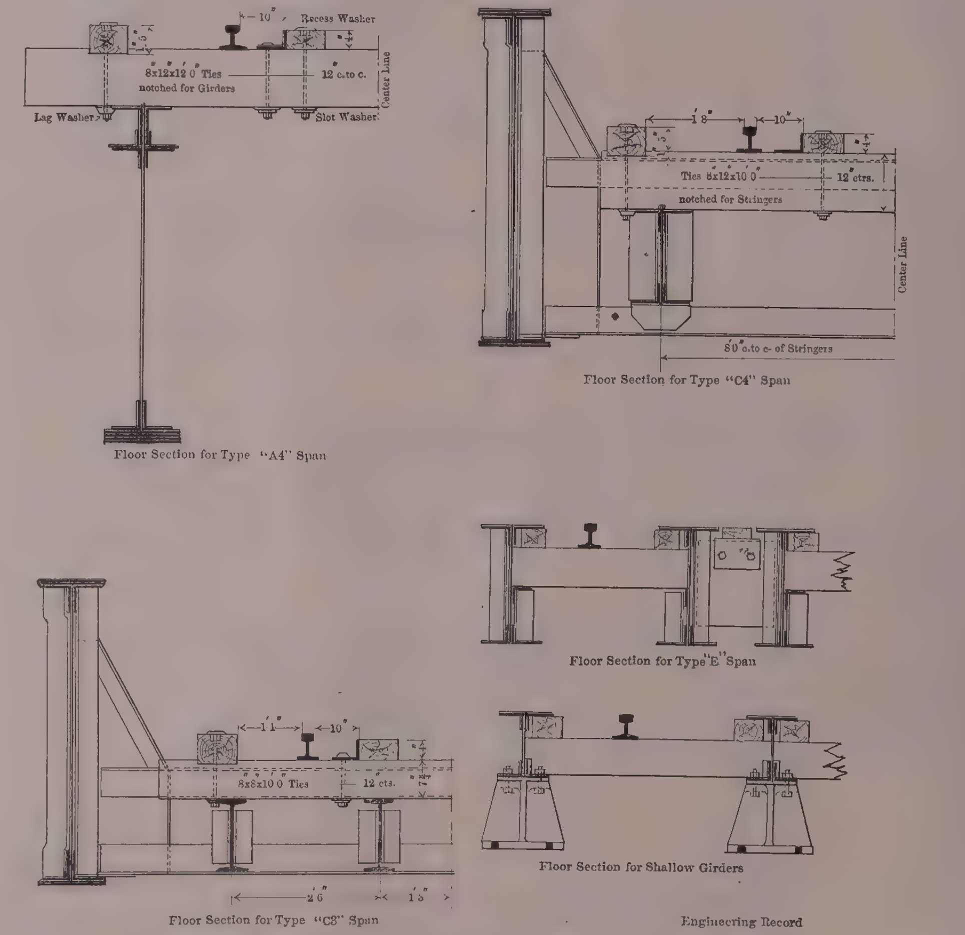
Lake Michigan, like other great lakes, is subject at times to sudden fluctuations of water level, due, it is believed, to changes in barometric pressure. These fluctuations not infrequently amount to 1 ft. or less, and occasionally to as much as 3 to 5 ft., and in one instance it is estimated to have been as much as 7 ft. As a consequence, sudden and violent currents are then developed, both in the entrance channels and in the reaches of the rivers leading from them, and vessels moored to the docks have their lines parted and the docks themselves at times suffer considerable injury. These fluctuations of water level are technically known as "seiches," and are commonly called "tidal waves." The current thus produced is locally termed an "undertow."

At several of the harbors visited "undertow" was reported to occur from wave effect alone during several storms when there were no appreciable fluctuations of lake level. From such inquiries as the board was able to make in the time at its disposal, this action appears to be caused as follows: During severe storms of long duration it is a well-known fact that waves travel in groups, separated by intervals of water in which wave disturbance is relatively small. When, during a storm, the individual waves of such a group break at the mouth of the entrance piers or between the piers themselves, successive volumes of water are projected with considerable velocity into the inner harbors. If, as is usually the case on the west shore of Lake Michigan, the entrance channel is wider than the bulkheaded river channel which forms the inner harbor, the effect of the projection of these successive volumes of water into the entrance is augmented.

This action may be roughly likened to that of a piston which at each stroke forces a mass of water into a pipe or channel. As long as the piston keeps working at fairly regular intervals the water will be kept moving with variable velocity in one direction. In like manner, so long as successive waves of a group break one after another in the entrance channel they produce a dynamic effect which prevents the confined water from escaping, but when the last wave of the group has broken and it is succeeded by a stretch of water in which there is comparatively little wave disturbance, the forces which served to prevent the outflow at the end of the piers no longer act and the confined water for a time moves out, producing both side currents and direct currents of considerable velocity.

As the force of a breaking wave is much greater on the surface than near the bottom, the first outflow will start near the bottom along the line of least resistance and will produce the "undertow" of which complaint has been made. The term "undertow" as used on Lake Michigan does not, however, apply solely to a flow along the bottom, but is applied also to any sudden current, either upstream or downstream, in any part of the cross-section of the waterway.

Lake Michigan is unique among the Great Lakes in that there are several of its important ports at which navigation is carried on during the winter season. The following regular lines of steamers at the harbors visited by the Board operate during the entire year: From Ludington to Manitowoc and to Milwaukee; from Manitowoc to Ludington, to Kewaunee, and to Frankfort, and from Racine to Milwaukee. More trouble from ice is said to be experienced at Ludington than at any other of the six harbors visited by the Board.



Floor Section for Type "A4" Span

Floor Section for Type "C4" Span

Floor Section for Type "E" Span

Floor Section for Shallow Girders

Floor Section for Type "C3" Span

Engineering Record

Standard Floor Sections, Chicago, Milwaukee & St. Paul Ry.

Plan of Improvement Proposed.—In order that the action of waves entering a harbor shall be reduced to such an extent that shipping will not be inconvenienced, one of two conditions must exist—either the banks of the entrance and harbor shall have or be given such slopes that the waves may run upward, and so dissipate their injurious energy, or an area of water should exist or be established sufficiently large to permit the force of the waves to be greatly reduced in expanding, the waves entering an interior basin tending to expand in a circle about the entrance as a center. The first condition, that of a sloping shore, is rarely obtainable owing to the fact that the shore line is just that part of the harbor which is usually needed for wharves, docks, etc., and the latter, in order to serve all purposes of their construction, must have faces vertical or nearly so, these vertical faces allowing the waves to travel along them, or to be reflected, with but little diminution of energy.

Accordingly, where the harbor is comparatively small and is well provided with docks, the first consideration being impracticable, the reduction of storm waves must be accomplished by the second condition, that of a large expansion basin inside the main entrance. In harbors of the kind under present consideration, formed by deepening the mouth of a small stream, the fact that the town existed adjacent to the water course before the harbor was developed prevents land being taken for this purpose, and in addition the configuration of the ground usually precludes any such method at a permissible cost.

It therefore becomes necessary in such cases to establish the expansion basin in advance of the shore by means of breakwaters, using a type of harbor construction similar to that which has been in successful use at the Upper Entry, Portage Canals, Lake Superior, for three or four years. Such a general type is recommended by the board for the specifically named harbors under its consideration.

For this type of harbor construction the breakwaters should, theoretically, in order to afford the greatest protection for the least length, be given a direction perpendicular to the line of approach of the waves caused by the heaviest and most objectionable storms (i. e., parallel to the waves of such storms), but they should also fulfill the condition that the entrance between them be in a depth of water which will allow the largest storm waves to pass without breaking. They should make with each other an angle large enough to permit sufficient expansion of the entering wave, and they should be far enough apart to allow a vessel to enter in the worst weather without danger of striking on either side. The distance from the breakwater entrance to the harbor pier entrance should be sufficiently great to allow the expanding wave to lose its injurious energy and also to permit a vessel to "straighten up" before reaching the pier entrance. Whenever there is considerable movement of sand or ice along the shore the breakwater should be extended to the shore line to avoid an accumulation of sand or ice in the basin, a condition which otherwise would be apt to occur.

Exterior of Hanan Factory, Showing Concrete Lintels and Brick Walls.

At the Lake Michigan harbors visited by the board it is believed that the above conditions can best be fulfilled by placing the breakwater entrance in about 30 ft. of water (or less if the heaviest storm waves pass shallowed depths without breaking or if other special local conditions will permit such lesser depth), making its width from 250 to 400 ft., and giving the breakwaters themselves directions such as to make an angle of about 90° with one another, where this can be done without preventing their extension toward such points of the shore as will be most conducive to economy. The requisite expansion area in most cases cannot be secured without allowing a distance of at least 1,200 to 1,500 ft. between the breakwater entrance and the pier entrance. When practicable the outer ends of the harbor piers should be in a depth of from 12 to 15 ft., and the breakwaters should be so placed that the mid-channel line of the piers, if prolonged, will pass through the center of the breakwater entrance, and although ordinarily to be given in addition such a location that this mid-channel line will bisect the angle between breakwaters, other locations are allowable, as in the case of Ludington Harbor, Mich., wherever the piers are not at right angles to the general trend of the shore line. The harbor piers should be at least 200 to 300 ft. apart, and if not parallel should be farthest apart at their shoreward ends, so as to reduce wave action in the inner harbor. An extra width of a few hundred feet at the shore line would have been very advantageous in nearly all cases.

Wherever breakwaters of the proposed type are added to existing harbor pier constructions of the usual type, the harbor piers already built will no longer be necessary for protection against storms and will be needed only as revetments to prevent the sand and mud from sliding into the channel. In most cases this would require the maintenance of the piers only far enough from the shore to reach a depth of about 12 to 15 ft., this distance, however, varying with the stability of the material through which the channel has been dredged. In nearly all cases of harbors under consideration by this board, the complete plan, as above outlined, would involve the final removal of a portion of the outer ends of the piers.

While the best possible results would be secured by the formation of a complete basin as above indicated, it is believed that considerable relief at all of the harbors in question can be obtained by constructing merely the outer portions of the breakwaters, beginning in each case at the breakwater entrance and building such lengths as are indicated hereafter for the respective harbors, leaving the extension or completion of the full plan to follow such development as the future conditions at the locality show to be advisable and the future needs of commerce require.

The Board is, therefore, of the opinion that for harbors like those under discussion, where the existing entrance channel is enclosed by approximately parallel piers projecting at right angles from a straight and sandy coast upon which wave action is severe, where trouble is encountered from ice in winter, and where the varying direction of storm winds makes entrance between the piers difficult for vessels at such times, the only entirely satisfactory form of improvement must consist of an artificial outer harbor formed of two breakwaters whose outer ends make an angle of approximately 90° with one another, and whose inner ends turn in at right angles to the shore line, following the principles previously explained.

In some cases it might not be necessary to remove the outer ends of existing inner piers, even where the distance from their ends to the breakwater entrance may be less than 1,200 ft.; but experience would soon determine what was advisable at each locality.

Breakwaters of the type proposed will probably permit all waves entering between their outer ends to expand within the enclosed area between them, so that by the time they reach the inner piers their height will be so reduced as to cause little inconvenience.

The shore extensions of the breakwaters and sand catches on shore will prevent drifting sand from entering into the area enclosed between the breakwaters, and when the shore line builds out beyond the angle connecting the shore extension with the outer portion of the breakwater the inclined direction of the latter will facilitate the movement of drifting sand and ice along the outer face of the breakwater.

It is believed that it is advisable to plan breakwaters for harbors like those under consideration with a view of ultimately completing them, should it ever be found necessary, on the type proposed. With many harbors, where the necessities of commerce are not great and for which appropriations are limited, partial protection can be obtained by building only a portion of one or both of the breakwaters and adding to them from time to time as necessity arises and as appropriations become available, in such manner that all work done may tend toward one harmonious final plan.

The primary object of these breakwaters and piers is to aid navigation by affording a safer entrance and stilling the inner harbor. Their construction should, therefore, be governed accordingly. They are not intended for use as private docks or places of business, and all reasonable means should be employed to prevent their use for these purposes. While it is generally conceded to be the province of the Government to develop such portions of a harbor as may be used in common by all, it is believed to be incumbent upon the private interests of a community to make such improvements as cannot be shared equally by all; and this has been recognized by Congress, which has made it unlawful to use Government piers or other works of harbor improvement for dock fronts or for commercial purposes.

It is therefore recommended that from original shore lines outward to any subsequent shore lines these piers and breakwaters be forever retained, and rebuilt from time to time as far as practicable, in such manner as to prevent the movement of sand from outside into the pier channels, and to allow the free expansion of waves. It is further recommended that prior to (and, in the case of those already built, after) the construction of these piers and breakwaters the United States acquire a strip of land at their shore ends at least equal to double the width of the shore ends, so that the riparian rights to the accretions next to them shall belong to the United States, and not be available for private dockage and other similar purposes, such private ownership and occupation being injurious to the public interests.

Materials of Construction.—In a growing country whose harbors have to accommodate a commerce not only steadily increasing in amount, but carried in vessels constantly increasing in size, the width of entrance and of channel, as well as the depth and other features, must be changed from time to time to conform to the conditions imposed by the development in vessels and commerce.

The history of nearly all of the more important harbors on the Great Lakes shows an increase of depth from 10 to 12 ft., which was formerly sufficient, to 20 or 21 ft., which is now necessary for all the larger vessels. The width of entrance has in some cases had to be increased, and in others what formerly was adequate for all purposes now restricts or inconveniences navigation. In at least one instance the entire artificial harbor of refuge was abandoned and another larger one was built farther out in the lake. This element of development and change must necessarily affect the character of the works of harbor improvement, and the construction of breakwaters or piers of permanent material, such as concrete or large stone, would be inadvisable where a change of conditions might reasonably be expected, when a structure of timber and small stone could be built at less cost and removed at correspondingly small expense.

In many cases where timber piers exist and produce no complaint from vessel men, a strong protest would be made by the latter against replacing the piers in concrete or large stone; for with the modern type of steel vessels a contact of vessel with a pier in the former case is by no means as serious as with the latter material; and where harbor works are built of hard, permanent materials, there is always a demand for more sea room than is considered necessary with the softer, perishable materials, such as timber. On this account there are harbors with restricted entrance channels where it would be an inconvenience or a menace to navigation to place a concrete top or superstructure on the crib piers as they are now situated.

In fresh water, timber, although called a perishable material, is such only above the water; below the water level it lasts indefinitely and may be considered permanent as far as decay is concerned; but it is in many localities on the lakes exposed to abrasion by the ice and may be broken by waves or by drifting material thrown against it in storms. The form in which it is ordinarily used is in the shape of a crib sunk and held in place by a filling of stone. A crib built in this manner is not rigid and will have a small amount of motion under the shock of the waves, owing to the elasticity of the timber and the flexibility of the corners or joints. This might be diminished in new work by the use of diagonal tie rods, but the older cribs do not have them and their introduction into such cribs is impossible.

In all cases where there is a reasonable doubt as to the sufficiency of the harbor works to accommodate the commerce which may seek the locality, the structures should be of timber or of other materials easily removed when occasion requires the enlargement of the harbor. Stone of a size which can be handled by a dredge might be suitable in some special localities. Very large stone would be difficult and expensive to remove, and the removal of concrete would usually be still more costly.

In many harbors where the seaway is sufficient the cribs could advantageously be capped with a superstructure of concrete. This concrete should be started at a depth sufficient to avoid all probable danger of the timber of the crib becoming exposed by a change of lake level and thus made liable to decay. The concrete should, for reasons of economy, be built no higher than necessary, which in some harbors, it is believed, will, after a study of all conditions, give a less height than was given the original timber structure. Where vessels are liable to come in contact with the concrete, a heavy timber fender should be provided. If a concrete-capped breakwater is exposed to storm waves striking it with force, it is believed that it should be protected on the lake side with a mound of stone or concrete blocks, the larger the pieces at the surface of the mound the better. Every means which at reasonable cost will stiffen the timber crib substructure and also the entire construction should be adopted as far as practicable.

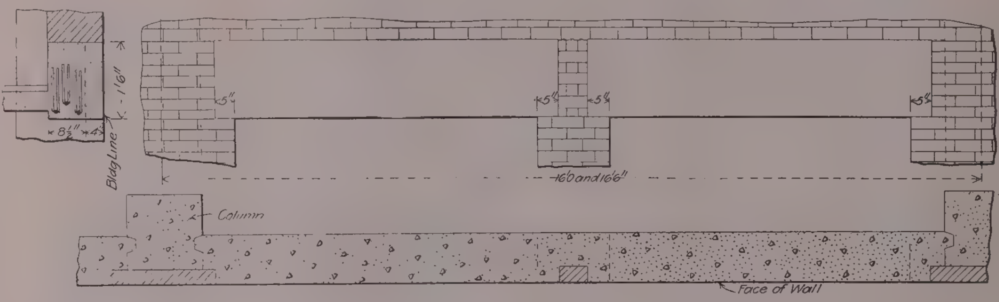
Structures which there is reason to believe will remain and serve their purpose indefinitely may in many cases be built advantageously entirely of concrete or of large stone. Where a smooth surface is preferable, as along the channel side of piers forming a harbor entrance, concrete will in most cases be found advisable. Where the depth is considerable, the concrete could with economy be placed on a rubble mound, but in such case it is believed that great precautions must be taken to avoid injury to the superstructure should the mound be disturbed by wave action or severe storms. Whenever practicable the use of concrete in mass is recommended where concrete is used.

The choice of materials will depend largely on the comparative cost of construction, taking into account the considerable cost of maintenance wherever timber is used. In some localities stone in large sizes can be obtained at reasonable prices; at others, owing to the long haul necessary, this material might be too expensive. The absolute first cost of construction of a concrete or stone structure will generally be higher than that of a similar structure of timber, but the ratio between the three materials will vary so greatly, according to locality, that no definite rule can be given, and as other conditions often create a preference for one type over the other it is believed that the question is mainly a local one, depending for its solution upon the particular harbor at which the work is to be done, bearing in mind, however, that structures designed to be permanent should preferably be built of permanent materials.

The Floor of the Bonhomme suspension bridge across the Blavet River near Lorient is of reinforced concrete slabs, except 299 ft. in the center of the main span. The bridge has two side spans of 121 ft. and a main span of 535 ft., the portions with the slabs being supported by diagonal ropes running down from the tops of the towers while the center part is carried directly by the main cables. The floor slabs are 4 1/3 in. thick, and strong claims for lightness are made for them.

A Reinforced Concrete Shoe Factory in Brooklyn.

The recent reinforced concrete addition to Hanan & Son's shoe factory in Brooklyn, N. Y., connected to the old four-story and basement building, 100 x 200 ft. in plan, of mill construction, is an interesting example of factory design. The addition, 120 x 200 ft. in plan, having four stories and a basement, is built with reinforced concrete floors and roof and with brick curtain walls and outside brick veneer. The new building was designed to conform to the regulations of the Board of Fire Underwriters and also to comply with the stringent requirements of the code of the building department of New York City for factory buildings. The old building faces on three streets. The new building is being erected in the rear of the old building, with its ends fronting on the side streets. A 27x96-ft. air and light court was left symmetrically in the rear of the old building; in the new building a 10x96-ft. court has been built in connection with the one in the old building, forming a 37x96-ft. air and light court practically in the center of the structure formed by the old and the new buildings. The new building also has a 28-ft. 9-in. x 97-ft. 8-in. air and light court formed symmetrically by its rear wall, the general plan of the new building being like a dumbbell.



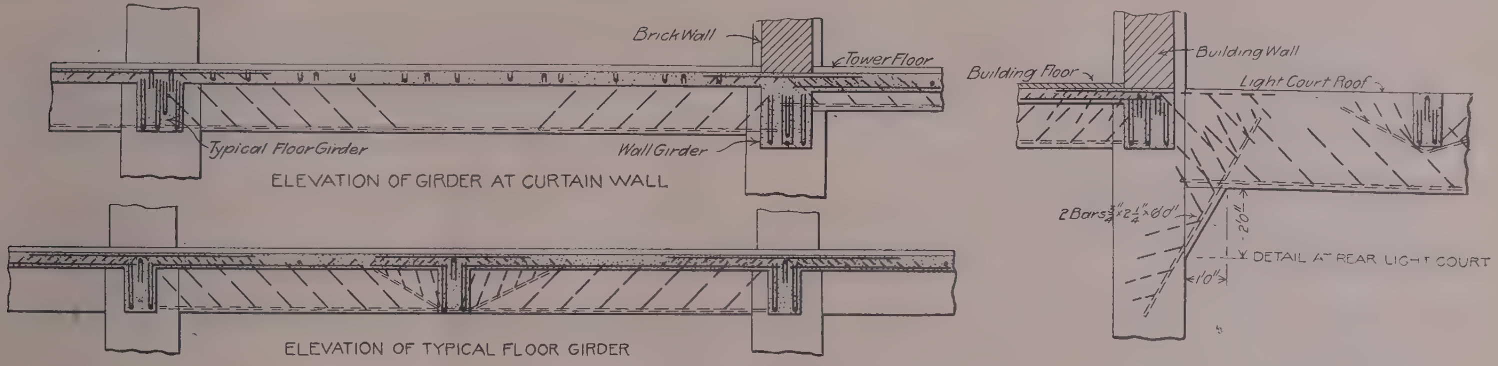
Details of Wall Girder used as Lintels for Windows.

The stairways, elevators and lavatories in the new building are placed in its four corners and back of the line of the inside longitudinal walls of the courts, leaving the main floor space entirely for machinery. Light, high-speed, electrically driven machines are largely used in making shoes, so the floors have been designed for a uniform live load of 125 lb. per square foot, and are carried by a beam and girder system heavy enough to provide for the excessive vibration of the high-speed machines. The main floor space in all of the building is divided in transverse and longitudinal bays, the former 16.5 and the latter 16 ft. wide, except at both ends, where a single transverse bay in each case is 16.25 ft. wide. The Kahn system of reinforcing is used throughout the building. The floors are carried directly by 14x18-in. longitudinal girders, 16 ft. on centers and by 10x18-in. transverse beams on 8-ft. centers. The details of the reinforcement in these typical beams and girders are shown in the accompanying illustrations. The beams and girders are supported by columns, 2 x 2 ft. in cross section for the basement floor and reduced to 14 x 14 in. for the top floor. The columns are reinforced with four vertical Kahn bars hooped with spiral steel rods and are carried on spread footings imposing a load of 3 tons per square foot to the sandy soil.

The arrangement of the beam and girder system of the floors provides a longitudinal strip of the building 11 ft. wide at the rear and 12 ft. wide at the front, adjacent to the existing building, forming towers in which elevators, stairways and toilets are placed. These four towers are on the street ends of the two light courts and are built differently from the remainder of the building by not being included within the reinforced frame, but are separate towers enclosed with self-sustaining brick walls. All four towers have reinforced concrete floor slabs, carried by transverse beams where concentrated loads occur. A part of the rear walls of the old building are used as party walls to form the front of the new building, and the walls of the old building on the two streets are extended 120 ft. as the end walls of the new building. Their beams are carried by the walls, no columns having been placed in the outer walls of the towers nor in the end or street walls of the towers.

The outside brick walls are curtains 12 in. thick for the whole building, except the towers, the brickwork for each story being carried by heavy girders and columns built in the walls in connection with the floor system. These outside curtain walls are built around the concrete wall girders and wall columns, however, so as to conceal the latter and make the exterior of the building harmonize as nearly as possible with the brickwork of the old building. In order to accomplish this it was necessary to adopt several special details in the design and construction.

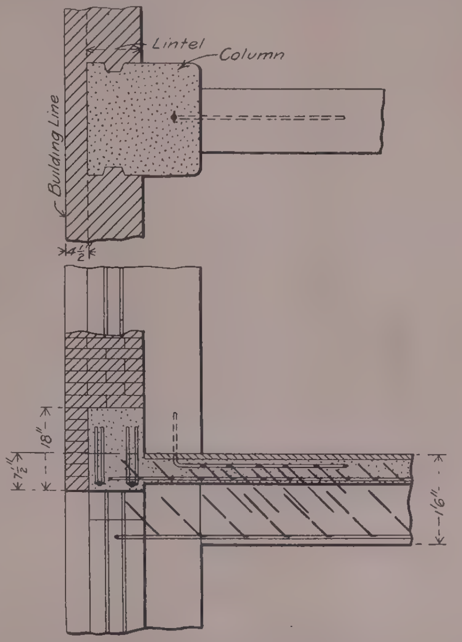
The exterior walls of the two street fronts and those in the light courts are the only ones exposed to view. The wall girders at each floor level carrying the brick curtain walls are located above the floor slabs and are built so as to form lintels for the windows, which are placed in pairs. The outside face of the girders is built out 4½ in. to make the girder flush with the outside face of the brickwork for a length of 5 in. each side of the joints of a window opening. The wall columns which carry the wall girders are also placed 4.5 in. back from the outside brick wall line, and the window frames are not less than 8 in. away from them, so that the brick veneer on the outside face of the columns may be ties through bonding with the brickwork, 8 in. face and 12 in. deep between columns and window frames. The 4.5-in. portion of the girders outside of the line of the columns built to form lintels is not reinforced, but is cantilevered from the wall girder. The loads on this portion of the girders are not heavy, however, as the brickwork directly above it is bonded into that over the main portion of the girder. The ends of the girders are keyed into the columns to prevent the lateral displacement of the former.



Detail of Floor Girders and Beams.

The window sills are made of concrete to harmonize with the lintels. They were cast in molds and set in place as needed. They were sufficiently reinforced with steel rods to insure them against breakage by such shocks as they receive while being put in place. Galvanized sheet iron window frames and sashes, glazed with ribbed wire glass, are used throughout the building.

The machines in the old factory are belt driven from line shafting by a Corliss engine, furnished with steam by three 100-h.-p. boilers in a separate 31.5x60-ft., one-story brick boiler house in the light court at the rear of the old building. The machines in the new buildings are arranged to be driven in groups by electric motors. The electric power will be supplied by three Westinghouse generators, of 37.5, a 75 and a 150-kw. capacity, driven by engines built by the Harrisburg Foundry & Machine Co. These generaors will be placed in a 38x69-ft. engine room in the corner of the basement of the new building adjacent to the boiler house. The old boiler house was rebuilt and three additional boilers added until the boiler capacity of the plant is now 600 h.-p. A new radial brick stack, 125 ft. high has also been erected by the Alphons Custodis Chimney Construction Co. to serve all the boilers. The dust and scrapings from the machines are delivered to a rubbish room by exhausters and consumed in the boiler furnaces.



Girder Carrying Outside Brick Wall.

A 10-ft. driveway, with 12-ft. headroom, gives access from the street at the opposite end of the building from the engine room, passing the tower adjacent to the old building to the portion of the enlarged old light court at the front of the new building not occupied by the boiler house. A 16x56-ft. loading platform is built in the basement in the second longitudinal floor bay back of the driveway, and the latter is arranged to afford liberal space for turning and backing up to the platform through changing the 16.5-ft. spacing of the columns carrying the floorbeam and girder system to spans of 29.5 and 33 ft. for entering and leaving the loading platform. The girders across these spans also carry the first story building walls. For each story above, a 16x28-in. girder is placed across the shorter and a 16x32-in. one across the longer span.

A conveyor leads up near the loading platform of the basement to the first floor and the empty crates will be sent up on it. Crated finished goods are delivered to the loading platform from the first floor by an incline. Packing boxes for the finished goods are delivered into the basement from a slide at the further street front.

The court at the rear of the building starts at the first floor level at which it is roofed over with vault lights carried on reinforced concrete girders and beams, increasing the floor area of the basement. The vault lights are supported by transverse 12x30-in. girders, resting on the regular floor columns at the building end and on the brick wall of the court at the other end, and longitudinal 8x16-in. beams on 7-ft. centers, carry the vault lights.

The building is built so that an additional story may be subsequently erected. It has a flat reinforced concrete roof carried by beams and girders spaced the same as those in the floors below. The roof, like all floors, has a 4.5-in. slab of concrete over and between the beams and girders, of the same quality as that in the floors. A layer of cinder concrete is placed over this 4.5-in. slab and a tar and slag roof laid over the cinder concrete. The reinforcing rods in the columns are carried up 12 in. above the roof finish so that the columns for the next story may be easily bonded to those already erected. An I-shaped skylight, with the stem part 16 x 99 ft. in plan and with 16x48-ft. ends, is built symmetrically in the center of the building.

The motors driving the groups of machines will transmit power to the latter through line shafting suspended from the ceiling. The timbers to which the shafting is attached are held in place by bolts through the floor above in each case. In order to provide for enough of these bolts to permit changes in the shafting, 1-in. gas pipes, 18 in. long, were placed on 4-ft. centers in the forms for all the beams and girders. While the concrete was being poured these pipes were held vertically by washers nailed to the forms and when the forms were removed the washers were stripped off at the same time. The pipes were also provided with screw cap plugs to keep the concrete out. The general arrangement of the machines is to place a row longitudinally in the two transverse floor bays at each end parallel with the streets and one row in each of the longitudinal bays parallel with the courts. These machines will be anchored to the floor by bolts to be placed in the flanged pipes which were set on the forms for the purpose before the floors were poured. These pipes are ½ in. and are placed in rows wherever a row of machines is to come. Plank platforms will be secured through these boltings on which the small machines may be fastened. Three longitudinal rows of pipes are placed to each row of machines, the rows of pipes being on 2-ft. centers and the pipes in the rows 2 ft. apart. This arrangement of fastenings for the shafting and machines is believed to be ample enough to avoid any necessity of breaking through the concrete to provide additional anchorages.

A complete sprinkler system for fire protection is installed with both pressure and gravity tanks and will be supplied with water from both the city mains and an artesian well. Special provisions have been made to drain the water of the sprinklers from the floors before it has time to seep through the concrete from story to story. The 4.5-in. reinforced concrete floor slab is covered with 1 in. of granolithic flooring. The surface of this flooring is sloped toward small copper drains extending through the outside walls of the building. One of the drains is placed on the center line of each transverse and longitudinal bay ending in an exposed face of the building. All door sills are raised 1.5 in. above the floor to impound enough water from the sprinkler system to quench falling embers during a fire. All door openings are provided with tin-clad automatic fire doors.

The building is erected on a comparatively favorable foundation of sandy loam and clay. Two large abandoned cisterns, whose bottoms were considerably below the basement floor grade, were uncovered by the excavation for the building. The columns were carried to the bottom of one of these cisterns and braced against each other to prevent flexure, then the hole was filled around them with well-tamped earth. The other cistern was smaller and was filled to the bottom for column footings with concrete, and two footings cantilevered over it.

The reinforced skeleton frame of floors and columns for the entire building was erected before work was commenced on the brick walls. The beam and girder system for all of the floors being so nearly the same no unusual difficulty was experienced in erecting the forms for the concrete. The first floor was completed before work was started on the second, and each of the other floors was finished before work was commenced on the floor above. Enough forms were built for the beams, girders, columns and floor slabs for two floors, and as fast as the concrete in one floor was set the erection of forms for the portion of the next floor over the finished work was commenced. The forms for the first floor were used on the third floor and those for the second were used on the fourth, the similarity of construction permitting the interchange without much alteration of the forms.

The concrete was mixed quite wet in the proportions of 1 part cement, 2 parts sand and 4 parts gravel for first 3 floors. Broken stone was substituted for the gravel in the upper floor and the roof. Giant Portland cement was used. Two Smith mixers were placed in the court at the rear of the new building and mixed all of the concrete, which was handled from the mixer to the various parts of the work in two-wheeled buggies. A hod hoist operated by an American hoisting engine, was built up the wall of the court as the work advanced, and the buggies and concrete materials were elevated to the different floors by it. A second elevator, operated by a Lidgerwood engine, was also installed in this court and handled the other construction materials. The outside brick walls were carried up from each floor, the masons on the outside working on platforms cantilevered out from the floors and those on the inside on scaffolds built up from the floor.

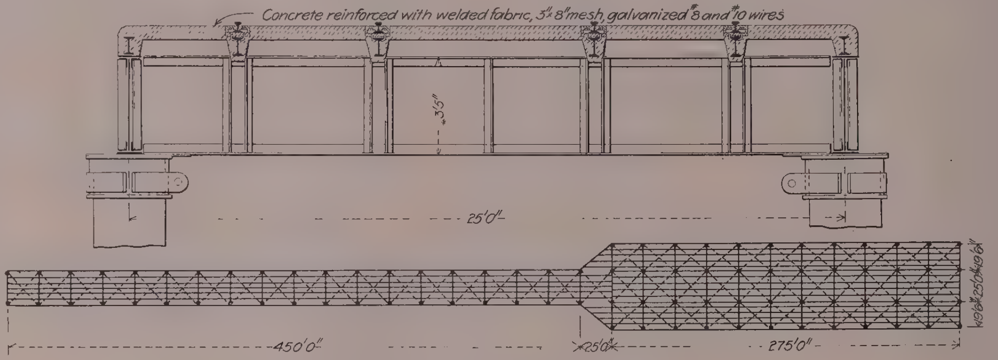
A fire insurance rate of less than 20 cents per $100 was offered on the building, which may decide the owners not to carry any fire insurance, believing it a safe risk for them to carry themselves. The rate on neighboring buildings of mill construction is 45 cents per $100.

The building and its novel features and arrangements was designed and its erection supervised by Mr. Henry Kissam, of New York. The reinforced concrete work was laid out by the Trussed Concrete Steel Co., of Detroit, Mich., and executed by the Concrete Steel and Tile Construction Co.

The Cienfuegos Screw Pile Pier.

The pier for the Cuban Central Railways in Cienfuegos Bay, Cuba, is 750 ft. long and from 25 to 64 ft. wide. It is built with cast-iron sectional screw piles and a steel and concrete deck. It is built in 20 ft. of water at a moderately sheltered location where there is an average tide of about 16 in. The detail designs were made and the contract was awarded for a pier to be built with screw piles adapted for use in a sand bottom. Owing to the necessity for a change in the location of the approaches, the pier was ultimately built in a different place where the bottom was hard coral rock in which the piles could not be screwed as at first intended, but were eventually firmly driven so as to utilize the material already delivered.

The pier is perpendicular to the shore line and has 31 transverse pile bents 25 ft. apart. These bents at the shore and outer end respectively are 25 ft. and 64 ft. wide, as indicated in the general plan, which shows the deck beams and girders in full lines and horizontal diagonal bracing by dotted lines. The piles are proportioned for loads of about 50 tons each from dead load and from the live load on the deck and on the two railroad tracks. The piles are hollow cast-iron cylinders 30 in. in outside diameter and 1⅜ in. thick. They are made in standard 12-ft. lengths connected by bolts through inner horizontal flanges. The lower section, 27 in. long, is special and provided with a beveled cutting edge and with two turns of a screw blade 5 in. thick at the root.


Concrete reinforced with welded fabric, 3"×8" mesh, galvanized #8 and #10 wires
3'5"
25'0"
450'0"
25'0"
275'0"
19'6"
25'0"
19'6"

General Plan and Cross-Section of Pier.

The piles are braced transversely by horizontal struts and diagonals. The top struts, just above low water line, are made of a pair of 10-in. channels about 4½ in. apart, back to back. They are connected with end pins through flange collars, each made in three pieces and bolted tight around the piles so as to be fixed in position by the friction. These collars have one flange joint on the transverse axis and two joints on the longitudinal axis through the piles. The longitudinal joints afford connection for longitudinal horizontal and diagonal members similar to those in the transverse planes.

The diagonal members are single 2-in. square bars with sleeve nut adjustments and loop eyes engaging the pins which connect the horizontal struts to the collar flanges. The upper end of the top section of the pile has an inside horizontal flange which affords a seat for the longitudinal girders bolted to it. These girders carry on their top flanges 8-in. longitudinal I-beams from about 4 to 5 ft. apart, which, as shown in the detail, support the deck slab and the track rails and are entirely enclosed in concrete. The deck slab, 6 in. thick, is made of 1 : 2 : 5 concrete reinforced with Clinton wire cloth.

Operations were commenced in March, 1905, when it was found that the bottom consisted in most places of 2 ft. of sand and shells overlying a deep bed of coral rock, varying in hardness, which could not be penetrated by the ordinary action of the pile screws. The two piles for the first bent were handled by a land derrick and great efforts were made to sink them by the combined use of a pile driver hammer aided by a powerful water jet and by screwing them down. By these means the first two piles were finally sunk to a depth of 8 ft. in about one week and the next two piles were sunk in about four days. It then became apparent that this method was impracticable for the rest of the work and new measures were resorted to which proved much more rapid and economical.

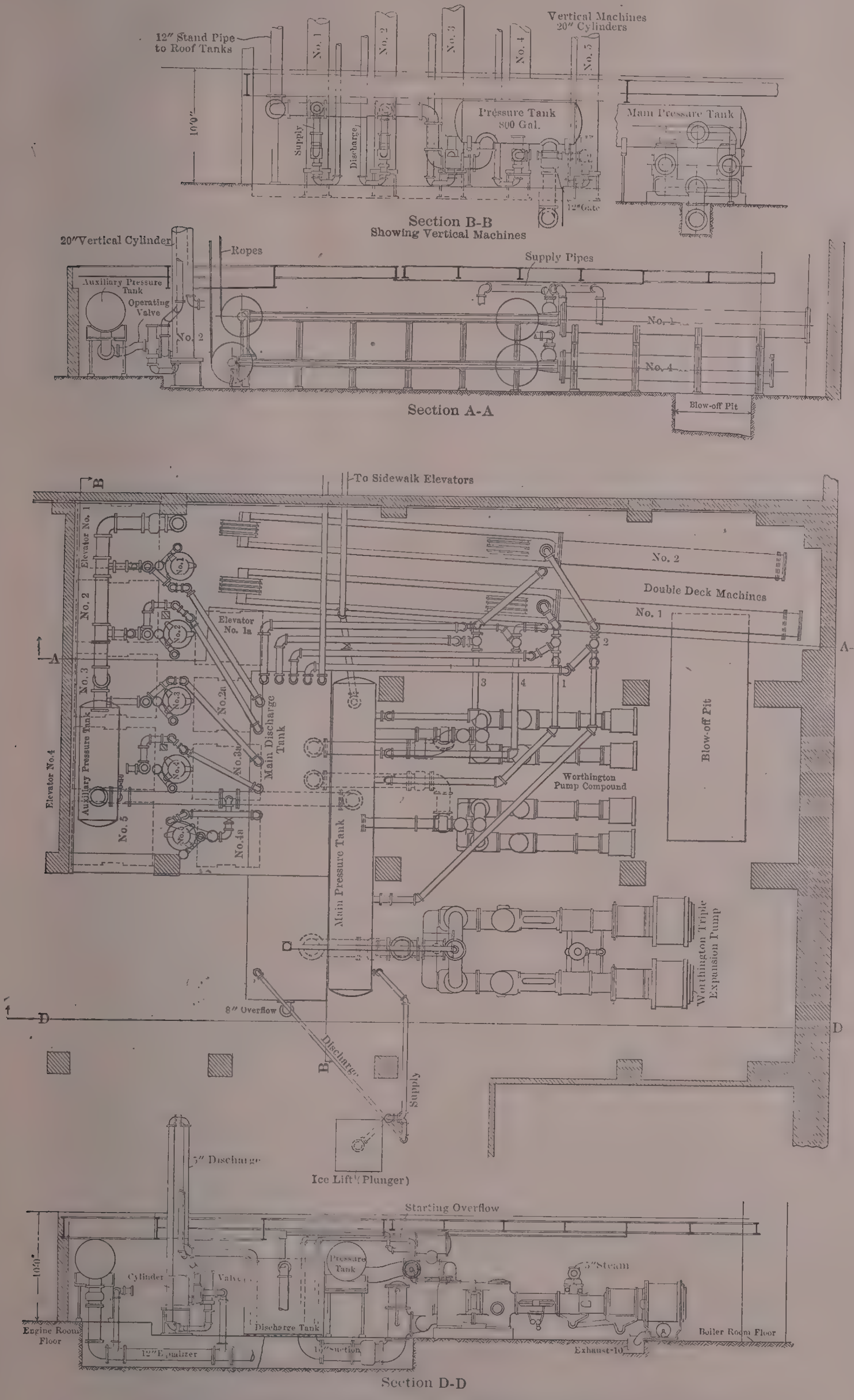
By the use of a water jet at about 150 lb. pressure delivered through a heavy chisel-pointed nozzle, five 3-in. holes for each pile were sunk in the hard rock to a total depth of about 16 ft. in one-half day. The holes were located at the center and at four equi-distant points of a 3-ft. circle. Through the jet pipe dynamite cartridges were lowered to the bottom of the holes, the pile was removed and the wire caught at the bottom and connected to the battery. When these cartridges were fired the rock was broken sufficiently to enable the pile to be screwed down through the material. From 50 to 100 cartridges were used for each pile and sometimes it was necessary to explode them in three different sets at successive depths when the rock was very dense. The piles penetrated the rock to an average depth of 14 ft.

The piles weighed 420 lb. per linear foot and their successive lengths were assembled in position by the 55-ft. boom of a 15-ton stiff-leg derrick on the deck of a scow moved backward from the forward end of the pier. The piles were revolved to screw them into the bottom by means of a bull wheel receiving several turns of an endless wire rope engaging the capstan head of the hoisting engine. The piles were driven between fixed guides on the end of the scow which served to maintain them vertically and to space them accurately in a transverse line. Longitudinal spacing was governed by a braced wooden frame or horizontal template which was centered on the last bent of piles driven and extended to the derrick scow, the latter being securely moored in the required position. In deep water two templates were used, 10 ft. apart vertically.

A force of 20 men averaged two piles a day under favorable conditions. Pile driving was completed in August and the concrete deck was laid and the pier finished sufficiently to be used by vessels in December. About 1,050 cu. yd. of concrete was required; it was made with White's Portland cement and was hand mixed. The steel and iron in the pier have a total weight of about 2,000 tons and the original contract price for the work was $225,000. The pier was built by the Snare & Triest Co., of New York.

Mechanical Plant of the Hotel Belmont, New York.—IV.

Elevators.—The elevator equipment of the Hotel Belmont includes hydraulic machines, of both the vertical and horizontal travel types, plunger machines, electric equipments and automatic dumb waiters. Of the nine high-rise equipments, there are five intended for passenger service, for which there was sufficient space in the shafts to permit vertical machines, while for the other four, which are for freight and employees' service, lack of vertical space made the installation of horizontal machines on the boiler room level necessary. For the short-lift service elevators on the 41st St. side, which rise from the boiler room level to the sidewalk, the plunger machine was considered most convenient, as was also the case for the ice lift, which rises from the refrigerating machinery section to the floor above for delivery of ice. For the two service elevators from the laundry floor to the banquet room in the location shown in the kitchen plan printed on Jan. 6, the boilers below prevented the use of plunger equipments so electric machines were employed.



Arrangement of Pumping Equipment and Elevator Machinery, Hotel Belmont.

The five passenger elevators have travels of 285 ft. from the third basement or laundry floor level to the top guests' or twentieth floor, with the exception of the middle elevator, which rises 297 ft. to the twenty-first or employees' dormitory. Each is designed to carry 3,000 lb., the rated speed being 500 ft. per minute with a load of 1,500 lb. and a water pressure of 160 lb. at the machine. The cars are 5½x7 ft. in size and weigh approximately 2,400 lb. in each case. The four high-rise service elevators have differing distances of travel, two starting from the laundry floor level and the other two from the engine room mezzanine or fourth basement; they all rise to the employees' dormitory floor, a travel of 299 ft. for the two from the laundry floor and 310 ft. from the fourth basement, with the exception of one of the latter, which rises 323 ft. to the deck house on the roof. The machine having the highest rise, No. 1a, is designed for a maximum load of 2,500 lb., the other three having capacities of 2,250 lb. each. All are capable of operating at speeds of 500 ft. per minute with loads of 1,500 lb. and 160 lb. hydraulic pressure. All of these machines have standing rope control levers and 6-in. Otis differential operating valves.

As above stated, the five passenger elevators have vertical hydraulic machines, space for which is afforded by the 24-in. clearance between the partition surrounding the passenger shaft and the freight elevators. These machines are of the four-sheave type, with 20-in. cylinders, 40 ft. long, and are geared 8 to 1, the lengths of stroke of the piston and traveling sheaves being 35 ft. 8 in. for the 285-ft. rise and 37 ft. 2 in. for the middle car traveling 297 ft. to the dormitory. Each car has four ⅝-in. hoisting ropes and two counterweight ropes of similar size. The four high-rise service elevators have special horizontal hydraulic machines which are arranged at one side of the elevator pump room in the fifth basement, as indicated in an accompanying plan. These machines, which were double-decked for economy of room, have 24-in. cylinders, 21 ft. 4 in. long for the car No. 1a having 323-ft. rise, and 19 ft. 11 in. long for the others. They have four sets of sheaves, geared 8 to 1, and have further multiplying gear in traveling counterweights in the shafts, making the effective gearing 16 to 1. These machines operate through four ¾-in. ropes, but have four ⅝-in. ropes from the counterweights to the cars. The car of each of the nine high-rise elevators is equipped with a safety manufactured by the Security Elevator Safety Co.

There are five plunger elevators, four traveling up six stories from the boiler room level to the 41st St. sidewalk and one which rises one story from the refrigerating machinery department to the floor above for delivery of ice. Of the four sidewalk elevators, two have 3¾x5-ft. cars and are designed for maximum loads of 1,300 lb., at which loading they are capable of developing speeds of 50 ft. per minute. The third elevator car is 4½x5 ft. in size and the fourth 7½x5 ft., which have maximum capacities of 1,500 and 1,800 lb. and speed ratings of 50 ft. per minute when loaded to 1,000 lb. All of these machines have 9-in. plunger cylinders; the two smaller ones and the ice lift having 6½-in. and the larger 7½-in. plungers, the travel of the four sidewalk cars being 58 ft. 10 in.; the ice lift has a rise of only 10 ft. and a capacity of 1,500 lb. All of the plunger machines have rope control and the usual operating valve of the Otis Company.

The hydraulic pressure for the high-rise and plunger elevators is supplied by three Worthington duplex steam pumps in the pump room, one a 17 and 25 and 42x15½x24-in. triple-expansion pump and the other two, 14 and 22x11½x18-in. compound pumps, all of which operate under control of Ford pump governors to deliver a pressure of 160 lb. The pumps are all of the outside center-packed water-end type and are equipped with special starting connections and safety valves for relief of the water ends in case of excessive pressure. These pumps take their suction through 12 and 16-in. lines from a 10,000-gal. open discharge tank in the center of the pump room and deliver into a 2,000-gal. cylindrical pressure tank, which serves as a header from which the various machines are supplied. This main pressure tank is of ⅝-in. steel plate, 32 ft. long, 3½ ft. in diameter, while the discharge tank is a 6¾x7x29-ft. rectangular open tank.

The head is supplied by a roof tank auxiliary consisting of a 12-in. standpipe rising from the pressure tanks to the deck house on the roof, where connection is made to two 3,500-gal. tanks, 341½ ft. above the engine room floor. These are closed cylindrical tanks, 5x25 ft. in size, of light construction as they are under only about 15 lbs. pressure, the available standpipe head nearly equaling the pressure carried at the pumps. The usual air space is maintained in all pressure tanks in the basement, including the auxiliary 800-gal. pressure tank in the connection to the standpipe to the roof by means of two 9½-in. Westinghouse locomotive type air pumps. There is also an auxiliary supply and discharge system in close proximity to the sidewalk plunger elevators, consisting of a 6-in. supply line from the main pressure tank and a 6-in. return to the main discharge tank. The supply line terminates in a 3-ft.-8-in.x11-ft. cylindrical pressure tank of 900 gal. capacity, arranged vertically alongside the shaft, from which the 3-in. supply connections are made to the plunger control valves. The discharge connections are carried up 20 ft. to an open tank, 2½x5x10 ft. in size, from which a 6-in. line returns to the main discharge tank.

The two electric machines for combined passenger and freight service to and from the kitchen have each a travel from the third basement (laundry floor level) to the parlor, a rise of 61 ft. 8 in., the principal purpose of this service being for the accommodation of waiters and employees between the kitchen and storeroom levels and the dining-room, palm garden and banquet hall on the parlor floor. Owing to the undesirability of cutting through the laundry floor and into the boiler room below for a flush landing at the lowest point of their travel, the cars approach only within 3 ft. of this floor level, steps being used to form a landing. Each of these elevators has a maximum capacity of 2,250 lb., at which loading the machine will operate the car at a speed of 150 ft. per minute. The machine for each is installed upon the laundry floor close to the shaft so that the drum projects within it for a direct drive, and occupies but 40 sq. ft. of floor space.

Each of these is driven by an Otis electric machine with magnet control operated by a simple two-way switch in the car. This control has a system of acceleration by electromagnetic switching and provides for the immediate stop of the car if the hand is removed from the switch. The motor is operated from a 120-volt circuit. The rope drum of each machine is 30 in. in diameter with 28-in. face, there being two ⅝-in. ropes to both the car and the machine counterweight, as well as two of similar size between car and car counterweight. The equipment also includes an automatic slack cable switch and top and bottom limit switches in the hatchway, both of which act similarly in rendering the machine inoperative when opened.

Dumb Waiters.—All the dumb waiters are electrically operated and two, which travel in the main elevator shaft alongside the high-rise service elevators, are believed to have the longest travel given a dumb waiter in this country, making in all 28 stops. There are in all ten dumb waiters, five of which are operated by a dispatcher, who controls the entire movements of the cars when signaled, and the remainder, which have only single-floor travel, are controlled upon the "call and send" system. These latter machines are for communication only between the storeroom and kitchen floors, and their controlling mechanisms are thus of a very simple nature. They are arranged for operation in either direction from either floor by push button control, but are in all cases inoperative when their doors are open.

The remaining five equipments include the two high-rise machines which are arranged for stops at all 28 floor levels of the building, a travel of 323 ft.; two making six stops from the fourth basement to the lobby mezzanine level, a travel of 63 ft., and one making six stops from the laundry floor to the banquet room, a rise of 66 ft. These are controlled from dispatching stations on the kitchen floor adjacent to the hatchways, from which they are operated when employees signal to the dispatcher to inform him as to the movements desired. For this purpose each dumb waiter has a separate control switchboard at the dispatching point. Each board has a "call" and a "send" annunciator for signals from the various floors, a series of push buttons for signaling to any floor and the motor controller for actuating the machine. The cars are in all cases operated by automatic high-speed machines which consist of the usual hoisting rope drums driven direct through enclosed worm gears by electric motors. To each is attached a horizontal slate panel containing the control mechanism by means of which the automatic operation is secured, this consisting of a revolving contact plate rotating with the movement of the car, and contact fingers corresponding with each floor.

In the operation of the dumb waiters, a dispatcher is in constant attendance at each of the control switchboards in the kitchen. When a car is needed at any floor the attendant pushes the "call" button at that floor which informs the dispatcher, by the bell and drop of the call annunciator, concerning the floor at which the car is desired. He then turns the controller handle around the dial until opposite this floor and then pushes the starting button, when the car, if not in use and all doors are shut, immediately travels to the floor indicated and stops there. As soon as the car starts a lighted incandescent lamp upon the switchboard goes out and remains out as long as the car is moving; when this lamp lights up, indicating to the dispatcher that the car has reached its floor and stopped, he rings a buzzer at that floor to call an attendant to the dumb waiter. Not until then, however, can that attendant open the door, as all dumb waiter doors are always locked except when the car is at the floor and makes a contact in the shaft releasing the electric latch; furthermore, the car cannot again be started until the door is shut again. When the attendant wishes the car sent to any other floor, he pushes the "send" button at his floor which signals the dispatcher upon the "send" annunciator the floor to which to dispatch the car. The car controller at the switchboard operates by directing the motor supply current to the contact fingers of the automatic mechanism, so that the motor starts and runs until the car reaches the corresponding floor when the contact strip passes out from beneath this finger. The entire elevator equipment, including hydraulic pressure machinery, and the equipment of electric machines and dumb waiters, were installed by the Otis Elevator Co., New York.

Pneumatic Tubes.—An extensive equipment of pneumatic tubes has been installed for the dispatch of orders, letters and small packages between the various floors. The tube extends from the main floor to the deck house on the roof, a vertical transmission of nearly 300 ft., which is the highest ever attempted. This, together with other long transmissions to the upper floors and the large number of tubes to the lower floors, made the installation a difficult one. There have been installed two systems, each with a central station in the main office on the rotunda floor, one of which includes the tubes running to the upper floors and the other to the stations on the first and sub-surface floors. The former has tubes leading to the various sub-offices on the bedroom floors, and to the hand laundry in the deck house, by means of which guests in all parts of the house may quickly receive telegrams, letters, visitors' cards, keys and the like. The other system has a large number of stations in the service section of the building, including a tube to the 41st St. supply entrance, one to the cashier in the main restaurant, one to the cashier in the serving room, one to the carriage office at the Park Avenue entrance, one to the telegraph office, one to the kitchen checking table, one to the barroom cashier, one to the wine room, one to the storeroom, one to the timekeeper's office at the 41st St. entrance and one to the engineer's office.

Practically all of the tubes are concealed, many of them encased in partitions and columns. The tubes at the central station connecting with the upper floors have a downward discharge, the carriers dropping out in a dished receiving cabinet, while those at the other central station connecting the rotunda and the under-floor stations have an upward discharge into a circular deflecting cabinet. An interesting feature is in the use of different air pressures for the different lengths of tubes owing to varying heights of transmission. The air compressing machinery consists of a special design of air compressor having an air cylinder very much larger in diameter than the steam cylinder so as to constitute a blowing engine rather than an air compressor as commonly regarded, yielding a large volume of air quickly when the automatic governor opens the steam connections. There are also two tanks of 150 cu. ft. capacity each, located on the floor above the compressor, one a storage tank receiving air directly from the compressor and transmitting it through a reducing valve to the other, an equalizing tank. This latter has pipe connections to all of the pneumatic tube stations, where reducing valves are employed for regulating the amount of air pressure in the different tubes. Provision is made for increasing the degree of pressure upon any one or more of the tubes, in case it should become necessary to use more than the normal amount on account of any accident or misuse of the tubes. Cross connections are made between the main feeders, so that if a sudden demand is made in one section of the system, the air supply can be drawn from the other sections as well as directly from the main pressure supply. The system has been installed by the Miles Pneumatic Tube Co.

Refrigerating Plant.—The refrigerating plant of the Belmont Hotel consists of two Carbondale absorption refrigerating machines with a complete brine circulating system for cooling the refrigerators and ice cream boxes, also for making ice and cooling drinking water. Each refrigerating machine has a capacity of cooling 100 gal. of brine per minute from 10° to 0° F. and is arranged to be operated with exhaust steam from the circulating pumps at a pressure of from 2 to 8 lb., as may be necessary. There are two brine pumps, each with 10x8½x12-in. cylinders, two 10x4½x10-in. ammonia pumps and one drinking water pump 6x4x6 in. Generally only one brine pump will be operated. These steam-driven pumps, which are of the duplex type, use considerable steam and it is probable that they will supply enough to run the ice machine, but in case any additional exhaust steam is needed it will be taken from the other pumps, or the main exhaust steam system of the power plant. With this arrangement a very economical plant is obtained, even with duplex steam pumps, which possess the advantages of being very reliable and costing but little for repairs. These ice machines require heat and condense the steam, and assuming that the hotel requires 50 tons of actual refrigerating effect which the ice machine would produce with a 50-h.p. boiler, it can be figured that, since the steam from the pumps is used in this ice machine, the pumps are operated for nothing whatever; if, on the other hand, the steam is charged up to the pumps, then it may be said that the ice machine is run for almost nothing. This covers a very interesting question in connection with the refrigeration requirements of hotels where economy of steam is important.

The ice tank is 23 ft. by 11 ft. 11 in. in size and 36 in. deep, and contains 182 8x15x33-in. cans for making six tons of ice per day. This tank is capable of freezing 8 or 9 tons, if necessary, by running the brine a little colder. The ice is lifted out of the tank and handled generally by a crane in the usual manner. The water for ice making is supplied from the city mains after passing through a set of Buhring filters, especially constructed for ice making purposes; each cake of ice is perfectly clear with the exception of a core in the center and is free from any taste or odor. The brine in ice tank is not kept colder than 20° F., so that the ice does not freeze too fast. There is a galvanized drinking water tank containing brine coils for cooling the water which is circulated through a line of faucets to the top of the house, with a return to the tank. All the water from the city mains is filtered before entering the building, but this drinking water system has a special set of Buhring filters in addition. The main brine storage tank is of 6,000 gal. capacity, which acts as a reservoir of cold only, since the brine is cooled entirely in the Carbondale brine coolers forming a part of the refrigerating apparatus. The steam cylinders of the pumps are covered with magnesia and cased in Russia iron with brass bands and spun brass heads. Each pump has a positive-feed Rochester lubricator so as to control the oil supply.

Thermometers are placed on the inlet and outlet of the brine mains so as to indicate the actual freezing capacity of the machines. All the brine mains are insulated with Nonpareil cork brine pipe covering. The refrigerator boxes are of the Lorillard make, most of them being glass-lined, thus presenting sanitary surfaces. They are fitted with galvanized coils, most of the boxes having two coils, so that one can be shut off for melting the frost. In all 47 boxes have been installed in the hotel, both glass-lined and iron-lined, as follows: Glass lined—Poultry, 10¼x12¼x8 ft.; game, 5x10x8 ft.; fish, 8x3½x4 ft.; smoked meats, 9½x6½x8 ft.; butter and milk, 4¾x3x7 ft.; cooked meats, 6½x5¼x8 ft.; milk and cream, 11x6¾x8 ft.; milk and cream, 12x3x8 ft.; butter, 10x8x8 ft.; fruit, 10x8x8 ft.; eggs, 7½x5x8 ft.; cheese, 7½x5x8 ft.; pastry, 7½x3½x7 ft.; bakers, 5x4½x7 ft.; vegetables, 12x6x7 ft.; cooked vegetables, 4¾x4x7 ft.; cold plates, 5x3x3 ft.; ice, 3x2x3 ft.; cold plates, 6x4x3 ft.; cook's order, 7x3½x7½ ft.; cook's order, 3½x3x7½ ft.; fish, 6½x3½x4½ ft.; cold plates, 9x4x3 ft.; cold plates, 6x4x3 ft.; meats, 23x12x8 ft.; pantry, 9½x3x7 ft.; short order, 7½x3½x7 ft.; butter, 5x3x7 ft.; cold plates, 5½x2½x3 ft.; pantry, 2x3x6 ft.; pantry, 6½x3x7 ft.; cold plates, 7½x3x3 ft.; wines, 6½x3½x6½ ft. Iron-lined—Beer, 10x10x8 ft.; ale, 10x7x9 ft.; rhine wine, 8½x3½x7 ft.; champagne, 14x3½x7 ft.; mineral waters, 8½x3½x7 ft.; champagne, 11½x13½x7½ ft.; beer, 12¾x9½x8 ft.; ale, 11x7x8 ft.; oysters, 7x3½x8 ft.; clams, 10½x7x8 ft.; bar, 26x2¾x3¾ ft.; ice, 6¼x3¼x3 ft.: wines, 4¾x3½x7 ft.; wines, 9¼x3½x7 ft.

Vacuum Cleaning System.—A vacuum cleaning and renovating equipment of large capacity has been installed, including vacuum pumps, mechanical and wet separators in the basement, and riser lines for outlets in all portions of the upper floors. There are six of the riser lines carried up to the top floor through different portions of the building, there being in all about 200 connections for the hose and renovators used in the cleaning process. These outlets are so distributed that every floor has at least six, for convenience of carrying the hose to any sections of the corridor, and have automatic couplings enabling quick connections to be made. Non-collapsible hose is used, together with slotted-mouthed renovator nozzles, brush renovators, and other devices for the cleaning of various classes of work. This system will also be used for cleaning the air filter screens for the fresh air supply systems; this will obviate the necessity of changing screens for cleaning, which is a process that dislodges large amounts of dust.

All hose couplings are made with ground joints and in the piping all bends and angles are made by long-radius curves to avoid interference to the flow of the dust-laden air. In order to prevent the dust being caught in the piping system, special recessed pipe fittings are used, which present no obstructions and preserve the full inside diameter of the pipe throughout. The six riser lines join into a main header in the fifth basement, which leads through the boiler room to the Kenney separators and vacuum pumps. The former equipment includes both a centrifugal mechanical separator and a water bath separator. The air passes through the mechanical separation first, which removes about 90 per cent. of the foreign matter that is drawn into the system in cleaning, and thence through the water bath, which removes all of the finer dust which may have passed the former; this separator will also remove organic matter from the air if corrosive sublimate be added to the water bath. The vacuum pumps, which are installed in duplicate, consist of 10x16x10-in. Kenny steam vacuum pumps with mechanically-operated valves. Each has a capacity of 400 cu. ft. per minute. This equipment has been installed by the Vacuum Cleaner Co., New York.

Laundry.—The bundle work laundry of a large hotel usually varies little from the typical public laundry catering to this special line of work, but in the Hotel Belmont plant no pains nor expense have been spared to make this department ideal in all particulars. High ceilings, white walls, good light and perfect ventilation contribute to the highest grade of work. Also the systems of receiving the soiled linen, marking it, assorting it when finished and finally bundling the packages and sending them back to the guests' rooms, will exemplify the latest and most approved practice in laundry work. Two distinct laundry establishments have been installed, one in the basement and the bundle-work laundry in the deck house on the roof. The main laundry or flat work equipment is located in the third basement and consists of metallic sterilizing washing machines, centrifugal extractors for wringing the linen as it comes from the washers, a tumbler for shaking the goods out and large mangles for ironing all of the flat work, such as table linen, bed linen and towels, for the entire house. The soiled linen after being processed in this establishment, is sent to the linen room to be assorted and distributed to the various departments.

The bundle-work laundry has an equipment consisting of metallic sterilizing washing machines, a centrifugal extractor, a starch cooker, starching machines, "Hurricane" dry rooms, a steam press, electrically-heated ironing machines for collars, a large number of ironing tables with electric hand-irons for shirts and other small work. This equipment was supplied by the A. T. Hagen Co., Rochester, N. Y.

A Long Wire Sweep for Soundings.

A paper by D. B. Wainwright, Assistant, U. S. Coast Survey, in report for Survey for 1905.

There are some areas along our coasts which have plenty of water for deep-draft vessels but which can not be pronounced absolutely safe for navigation owing to the fact that pinnacle rocks, coral rocks, or ledges of small area have been found there as a characteristic feature. No matter how closely these areas may have been surveyed with lead and line, there is still a possibility of the existence of hidden dangers which have not been charted. This uncertainty is an inherent defect in the method. As a remedy a harbor and channel sweep was devised and has proved highly satisfactory for channels and anchorages; but as it covers in a traverse a width of only 65 ft. its employment for completely sweeping large areas, like Frenchmans Bay, Me., could not be entertained. Some other construction which would accomplish the desired result within a reasonable time was needed. The French Hydrographic Service has used a long rope sweep supported at intervals by buoys, but the most promising form for a sweep is one briefly described in the report of the chief of engineers, U. S. Army, 1903. Starting with the latter as a basis, the sweep used in Frenchmans Bay was developed.

The length of the horizontal dragging wire of the sweep is 1,000 ft., and it is supported at the desired depth by three large buoys, one at each end and one in the middle, and at intermediate points, at intervals of one hundred feet, by small buoys. The drag wire and the wires attaching the buoys were all of galvanized No. 12 American gauge.

The buoy wires were attached to the drag wire by swivels, and a swivel was also put in every 50 ft. to overcome the tendency of the wire to twist into kinks. Shackled to the lower end of each of the large buoy wires were two cast-iron balls (deep-sea sinkers) each weighing 63 lb. To the small buoy wires 9-lb. sounding leads were attached by snap hooks.

The top cone of each of the small buoys was provided with a socket to carry a small flag stick with a flag. Around the top of the flag stick was wrapped a pound of sheet lead. This was for the purpose of capsizing the buoy when its wire was slackened by the drag wire striking an obstruction and thus giving notice of the presence of a danger to navigation.

In operation three launches were used. The one attached to the center buoy by a 50-ft. line towed straight ahead in the direction it was desired to drag over, and was kept on this course by observing sextant angles for position and plotting the same on a hydrographic boat sheet. The other two launches were attached to the ends of the drag by a 25-ft. towline, and each directed its course so as to keep a specified strain on the towrope, as indicated on a spring balance attached to the latter, and at the same time make good a course that would be parallel to that of the middle launch. Position angles were observed with sextants on the end launches at regular intervals. These positions were plotted on the smooth hydrographic sheet and were used for drawing the path swept over by the drag. A sharp lookout for any unusual behavior of the buoys was kept up on the launches, and a patrol boat followed with spare buoy, anchor, and line to mark, for future development, any shoal spot indicated by the drag in the course of the day's work.

In Frenchmans Bay the rate of speed adopted was from 1½ to 2 nautical miles an hour, and the pull for each end launch 125 lb. This pull represented the resultant of the tension necessary to keep a half of the system at a certain curve and carry it ahead through the water at the required speed. The angle of the towrope with the general direction of one-half of the system corresponded with that of a diagonal of a parallelogram of forces, the tension and speed through the water being taken as the components. This angle was computed in advance and, together with the pull indicated on the spring balance, served to determine the course to be steered by the launch.

When not in use the buoy wires were kept wound up on one reel and the drag wire on another. When the drag was set from a steamer or cutter, a buoy wire and one set of heavy weights were attached to the end of the drag wire, and lowered slowly overboard until the upper end of the buoy wire was unreeled. One of the large buoys was then attached and lowered into the water, a small boat taking it in tow, carrying it away from the vessel. The drag wire was now paid out until the shackle for the first small buoy wire was reached. The latter and one of the 9-lb. leads were snapped onto the shackle and the paying out continued until the upper end of the buoy wire was unreeled, when a small buoy was hooked on and dropped overboard.

The paying out was again continued, the weights and buoys, small and large, being attached in their proper sequence. The launches then took charge of the system and it was towed along endwise until the center launch reached the beginning of the line to be traversed, when the end launches took up their proper position according to directions signaled from the center launch. The start was then made, and thereafter the end launches were maintained in their proper relative positions by a suitable code of signals given from the center launch.

To maintain the necessary transverse tension on the system and at the same time carry the system through the water at the required speed or its equivalent—maintain the tow rope at the proper angle while the spring balance indicated the specified pull—the end launches head out or away from the center launch. Should one of the ends of the sweep be observed to be in advance of its proper position, the launch having it in tow is given the proper signal, and it responds by heading still farther away from the center launch, thus slowing down that end. If, on the contrary, the end is falling behind, the launch heads in on a course more nearly parallel with the center launch, which has the effect of increasing the rate of speed of that portion of the system, at the expense of the transverse tension. This control of the end launches is a necessary feature, as the wind and tidal currents have more or less effect on the movements of the system.

The wire used was galvanized No. 12, American gauge; diameter, 0.08 in.; weight per linear foot, 0.017 lb. The length used for buoy wires was 49 ft. (0.83 lb.). This length was determined, first, by the depth at mean low water it was desired to have absolute certainty as to hidden dangers, namely, 35 ft.; second, the allowance for range of tide; third, the allowance for lift of weights due to pull of towrope. The total length of drag wire was 1,000 ft. This was divided into 50-ft. sections, for, besides being connected by swivels to a shackle every 100 ft. where the buoy wires were fastened, there was also an intermediate swivel, to avoid kinks.

The end and center buoys had the shape of double cones, each one 2 ft. high and 2 ft. in diameter at its base; weight, 30 lb; volume, 4.19 cu. ft.; displacement, 262.2 lb. in sea water; material, galvanized iron. They were strengthened by an inch flange at the junction of the two cones and a stay rod run through lengthwise. The latter was turned over at each end so as to form eyes.

Each small buoy was a double cone of galvanized iron, 1 ft. high and 1 ft. in diameter; weight, 6.5 lb.; volume, 0.525 cu. ft.; displacement, 33.5 lb. in sea water. The buoys were strengthened by an inch flange at junction of cones. No stay rods. Socket soldered on at the upper end for a small flag stick. Eye soldered on at the lower end.

The weights for the end buoys were two 63-lb. iron balls (deep-sea sounding sinkers) of 8 in. diameter. For small buoys, 9-lb. hexagonal sounding leads, 2 in. in diameter, were used.

The weight supported by the end buoys was as follows: Buoy, 30 lb.; sinkers, 126 lb.; 50-ft. drag wire and 49 ft. buoy wire, 1.7 lb.; total, 157.7 lb. The weight supported by the small buoys was as follows: Buoy, 6.5 lb.; sinker, 9 lb.; 100-ft. drag wire and 49-ft. buoy wire, 2.5 lb.; swivels and shackles, 2 lb.; total, 20 lb.

With the above weights the buoys were submerged one-half. It may be stated that in case of emergency, and in a locality where the submerged rocks are not worn smooth, an effective drag could be constructed, if wire and swivels were on hand, by using oil barrels or boats for the larger buoys and 5-gal. kerosene oil or paint cans for the smaller ones.

Book Notes

The first volume of a Chauffeur's Library has recently been published in France under the title "Principes and Recettes." It is an octavo volume of 500 pages in which the reader is taught the elementary theory of gasoline and steam engines, electric motors and the accessories of automobiles. The general management of a car is next taken up, and directions are given for handling it under all the conditions which arise on a tour over well-kept roads. There is a short chapter on maintenance, but it is very evident that the author believes amateur repairs are likely to cause rather than save expense. The remainder of the book is a collection of notes prepared in answer to inquiries by the readers of the "Vie Automobile." These notes are arranged in four chapters, relating respectively to technical, practical, legal and sanitary subjects, and contain data of much value to anybody contemplating a tour in France. There is also a bibliography of the automobile and a valuable vocabulary of French automobile terms. (Paris, H. Dunod and E. Pinat, 49 Quai des Grands-Augustins, 7.50 francs.)

The "Westinghouse Diary" for 1906 is like the book that found so much favor last year, but the technical information it contains has been somewhat enlarged. It is a pocket diary containing the usual pages for brief notes under their appropriate dates, fourteen pages of useful maps of parts of the United States and its over-sea provinces, fifty pages of technical memoranda and eight pages of miscellaneous information. The technical information has been edited in a remarkably successful manner, being presented in a concise form without trade padding. It includes sections on arc lighting data, belting, value of different coals, copper and aluminum data, cost of different equipments for interurban cars, energy consumption on railways, train resistance, trolley and feeder wire data, electric signal appliance curves, alternating-current formulas, gas engine data, commercial power of gases, heat units, incandescent lamps, heating value of liquid fuels, application of motors to machine tools and power required by the latter, mercury vapor converters, mercury vapor lamps, Morse chain data, Nernst lamps, operating hints for dynamo and motor owners, power plant data, power transmission, rule for pulley sizes, single-phase railways, speed charts, data on steam boilers, steam engine and steam turbine data, water-power data and wiring tables. The little book is well printed and attractively bound in convenient form for the vest-pocket. It has been issued for the Westinghouse Electric & Mfg. Co., by the Westinghouse Companies' Publishing Department.

The New York banking house of J. S. Bache & Co. sent out letters last summer to every banking institution having a rating of $50,000 or over, in the country, asking for information concerning the extent of their investment in bonds other than those of the United States. Prior to this time no information on the subject has been collected, but it has been evident that a growing proportion of banks' funds has been invested in this way in those sections of the country where the local demand for money is not so great as to prevent the accumulation of a surplus above the cash reserve. The data secured by the investigation, which brought replies from nearly four thousand banks in different parts of the country, have been analyzed by Mr. William C. Cornwell, whose report on the subject, entitled "Bonds as a Safety Reserve for Banks," has been issued by the company which gathered the information. The pamphlet contains a number of tables which will interest a good many engineers who have attempted to investigate the source from which came the funds for some of the enterprises with which they have been connected. The financial part of such enterprises is, unfortunately, generally overlooked by the engineer, who, if he would really study it carefully, would be in a position to assist materially those who are financing new railways and public service undertakings. The showing made in this book ought to encourage some of the engineers who have nice opportunities for the investment of capital in power developments, water-works, lighting and railway companies and the like, for it indicates that the bonds of a sound proposition conservatively capitalized and properly managed are gradually becoming recognized as a good investment for surplus banking funds.

The British Fire Prevention Committee has issued its "red book" relating to the fire test of a cement concrete floor with bays of various aggregates, which was described in some detail in the Current News Supplement of this journal on Dec. 2 of last year. The test was made under the immediate direction of Mr. Max Clarke, F.R.I.B.A., who supplies the following preface to the report: "At the present time there is a great divergence of opinion concerning what material is the most suitable fire-resisting aggregate for concrete to be used in the construction of floors and the like, and it may be said that there are some who would advocate each or any of the aggregates used in the tests now reported on. At the same time there are others who say that each of these aggregates is open to some special objection. It was with the view of settling in some degree such differences of opinion that this experimental test was undertaken. The test, however, did not go far enough to furnish any definite conclusions except to show the entire unreliability of Thames ballast concrete as a suitable material for this method of construction. As to the relative value of the concrete aggregates other than Thames ballast, no indisputable statement can as yet be made." Inasmuch as a full account of the tests was so recently printed in this journal it is hardly necessary to make any further comment on the report, except that it is sold at 2s. 6d. at the committee's office, 1 Waterloo Place, London. Another recent "red book" describes a test of a partition made of 2⅛-in. porous terra-cotta hollow tile furnished by the National Fire Proofing Co. and plastered on the fire side with two coats of mortar containing a handful of hair and a bushel of asbestic to each cubic yard of clean sand and half a yard of gray lime. The director of the test reports that it indicates the possibility of providing such partitions, having a length of 10 ft. and a height of 8 ft. 10 in., that will prevent the passage of flame and smoke from a fire burning for 2½ hours on the plastered side of the partition, raising the temperature to 1,980°, and then prevent the passage of water from the jet of a steam fire engine.

Just why so many authors consider it necessary to adopt the question-and-answer method of imparting information of a so-called practical character is difficult to ascertain. It is true that some eminently satisfactory books, like Forney's "Locomotive Catechism," have been written in this way, but equally good books, such as Baldwin's "Steam Heating," have attained great success among workmen of only elementary education, without adopting this sandwich style. The latest example of it is "Questions and Answers on the Practice and Theory of Steam and Hot Water Heating," by R. M. Starbuck, Hartford, Conn. It is a little book of 110 pages which would be just as valuable if side-heads were used to indicate the contents of each paragraph instead of the long-drawn questions that are employed. Instead of the question, "what is the average amount of coal consumption," printed in heavy type, it would be much better to use an italic side-head, "amount of coal consumption." It would also be well to be very careful in preparing the text of books of this class, intended for sale to people of limited means who deserve to be treated by authors much better than the class which has plenty of money to throw away on the popular novels of the day. The statement that it takes 7½ to 11 lb. of coal to evaporate a pound of water in a heating boiler and the assertion that radiation transfers heat from one body to another through such mediums as currents of air, to mention two examples from this little book, indicate a want of precision in ideas or language that are particularly unfortunate in a manual intended for the instruction of young workmen. There is, however, a large amount of useful information in the book concerning the selection and installation of steam and hot water heating apparatus. Just how accurate the tables are it is impossible to tell without checking them, which it is hardly worth while doing for the purposes of this review. In a general way, it may be said that so far as the practical working of laying out house-heating jobs is concerned, the book is a fair guide but some of the explanations of theory are not strictly accurate. There are also some suggestions that seem out of place in a book intended for the use of good workmen. For example, the statement that common earth mixed with weak salt water is a substitute for fireclay is not to be credited for a minute; such a mixture is mud, nothing more or less, and any attempt to use it for fireclay is jerry-work deserving the strongest condemnation. The book is sold for $1 by the author.

Der Eisenbeton Seine Theorie und Anwendung. By Prof. E. Moersch, Stuttgart, K. Wittwer; paper. 250 pp., 6.50 marks.

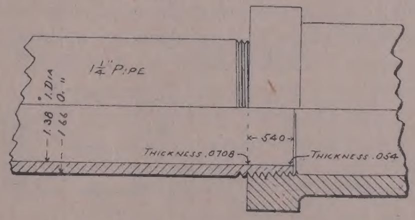
This book possesses the twofold merit of unusual clearness and great conciseness in presenting a great variety of information regarding reinforced concrete. The section devoted to the theory of such construction is particularly full. Attention should be called to the great variety of experimental results which are given, particularly those relating to shear, torsion, adhesion and the effect of spiral wrappings on the strength of columns. There is also an account of some particularly interesting investigations of the actual position of the neutral axis, showing a good agreement between theory and test. Another investigation relates to the combined influence of bending and compression, and a graphical method of working out such problems is given. There is likewise an account of experiments to determine the action of compression in beams, which were described in "Beton und Eisen" about a year ago.

The second part of the book illustrates and describes a great variety of reinforced concrete works executed by the Wayss & Freytag Co., who are responsible for the preparation of the book. The structures include manufacturing buildings, warehouses, stairs, arches, domes, foundations, piles, caissons, basement floors, highway bridges, basins for water and other liquids, and silos. While this part of the book is in one sense a trade publication, since it relates wholly to the work of this company, it should be borne in mind that the company has been a pioneer in the field of reinforced concrete and has spent a large sum in conducting experiments, which are still continued whenever a new feature of construction is proposed, for the purpose of ascertaining how far theory is a safe guide for practical work. The company has reason to be proud of its long and successful experience in building such structures, and there will be few, if any, readers who will fail to find the second portion of the book as instructive as the first section, written by Professor Moersch.

Letters to the Editor.

Reductions in the Thickness of the Walls of Standard Steam, Water and Gas Pipe.

Sir: All tables printed in the engineering pocket-books and in the catalogues of makers and dealers agree that the different nominal sizes of standard pipe shall be of the given thickness of walls. Some years since the writer found that pipe seemed to give out by corrosion much sooner than usual. Also, that very often in removing from its fittings pipe that had been in use for some time it would crush or break in the thread next to the fittings. At first this trouble was laid to the steel pipe then coming into general use, but a comparison between some pipe about 20 years old, then being taken out, and the new pipe showed a considerable reduction in the thickness of the walls. The attention of our dealer was called to this a number of times, but with little or no effect. The usual run of pipe in sizes from ½ to 3 in. varied from 5 to 15 per cent. under the weight given in tables as standard, and what we call "card weight.'



Thickness of Pipe.

Few people probably realize that a pipe which is a certain percentage thin or under weight has lost approximately double that percentage in strength or quantity of material to resist corrosion. Bearing in mind that a chain is no stronger than its weakest link, select as an example a 1¼-in. pipe threaded into a cast-iron fitting. Allow that the pipe screws into the fitting 0.54 in., as shown in the sketch attached, 0.54 in. being the length of perfect screw as per Kent's Pocket Book, page 195, edition of 1896. The standard dimensions for 1¼-in. pipe are also given in the sketch; weight per foot is 2.24 lb. Now assume that the pipe is 12 per cent. light (which is often the case); that is, the pipes lack 12 per cent. of 2.24, or 0.269 lb. of being full weight. Taking standard dimensions, a foot of 1¼-in. pipe takes $(1.38 + 0.14)\ 3.1416 \times 0.14 \times 12 = 8.03$ cu. in. of metal, weighing 2.24 lb., or $2.24 \div 8.03 = 0.279$ lb. per cu. in. of metal. Then the reduction in weight assumed is $0.269 \div 0.279 = 0.965$ cu. in. of metal per foot. To find the thickness of shell that this reduction in metal takes from the inside of the 1¼-in. pipe, we have $0.965 \div (1.38 \times 3.1416 \times 12) = 0.0185$ in. This would be slightly less if the average diameter of this shell were taken instead of the inside diameter, but the result is near enough for the purpose. This amount, less than 0.02 in., seems small, but let us analyze the case further. The thickness of 1¼-in. standard pipe at the bottom of the thread at the end of a threaded piece is $\frac{1}{2}\ (1.488 - 1.38) = 0.054$ in. To find the thickness at the face of the fitting into which the pipe may be screwed, we will assume that it screws in the depth of a standard "perfect" thread; that is, 0.54 in., then allowing for the increase in thickness due to the taper of the threaded end, namely, 1 in 32 with the axis of the pipe, we have $0.54 \div 32 = 0.0168$, which, plus the thickness given at end $= 0.054 + 0.0168 = 0.0708$, or in other words, the thickness of a piece of 1¼-in. standard pipe at its weakest point (at the face of the fitting), is 0.0708 in., less than 5/64 in. Deducting from this standard thickness the 12 per cent. assumed, or .0185 in., we have $0.0708 - 0.0185 = 0.0523$, or slightly over 3/64 in., or in percentage we have $0.0185 \times 100 \div 0.0708 = 26$ per cent. That is, under the assumed condition, a 12 per cent. reduction in weight gives a 26 per cent. reduction in strength and durability.

The manufacturers of pipe probably do not consider that a reduction in weight of 12 per cent. is of any importance, since they are putting into the pipe a material which is at least that much stronger when considering the tensile strength of the materials only, but when it comes to a matter of business honesty, the reduction comes very near being a steal. This subject is a live one with many pipe users and will bear some discussion on the side of the manufacturers as well as the users, and the writer would like to see it well threshed out.

January 3, 1906. J. C. Davidson.

Good Looks.

Sir: In commenting in your issue of Dec. 23 on the probable value of the decorative features of a handsomely designed sewerage pumping station for an English city, it was stated that some would look upon money paid out for this purpose as an unnecessary expenditure, also that the "true ideal from a strictly engineering point of view is the attainment of the end in view with the least amount of running expenses and fixed charges." As I doubt very much if the decorative features of this station tend to reduce fixed charges I am forced to the conclusion that it is bad engineering to design a station or in fact any structure if the pleasing effect costs more than one with these features omitted. [This by no means follows from the statement quoted.—Ed.]. Whether or not this reasoning is correct, I cannot but regret that The Engineering Record did not take the ground that sound engineering should encourage a reasonable expenditure for pleasing designs even if it does, with our public buildings, require a higher tax rate and with structures erected by public service corporations a slight reduction in the water-bearing power of their capital stocks. The accepted definition of engineering is "the utilization of the forces of nature for the benefit of mankind." Cannot engineering utilize the beauties of nature and the products of man to a reasonable extent, for the same purpose, or have our architectural brethren that sole privilege?

A visitor to Europe cannot help but notice the attractive design of pumping and electric supply stations of both public and private ownership there, and at the same time regret that in the United States, save in a few instances, so little thought is given to the architectural appearance of structures of the character mentioned. In making this comment full credit should, however, be given to the excellent example set by the city of Boston and the traction and electric supply interests in New York City for their willingness to make their power houses attractive in appearance. The Metropolitan, Kingsbridge, Manhattan, Waterside and Interborough stations in New York all show an effort on the part of the owners to secure a good architectural effect, and this effort should be encouraged. With such an example before it it is unconceivable how the Pennsylvania Railroad should have made use of the car-barn Renaissance in building the hideous power station recently erected for it in Long Island City. In justice to the corporation mentioned it should be stated that the building is not less attractive from an architectural standpoint than other water-front structures, notably the Astoria gas holder or the Erie grain elevator. It is to be regretted, however, that it is not at least a little better.

DIEDRICK KNICKERBOCKER.

TESTS OF PORTLAND CEMENT CONTAINING LARGE PERCENTAGES OF GYPSUM.

SIR: In 1903 a sub-committee of the Special Committee on Uniform Tests of Cement of the Am. Soc. C. E. was appointed to determine the effect of large percentages of gypsum on the constancy of volume and strength of Portland cement in both fresh and sea water. As a member of this committee, a series of tests were laid out by me extending over two years. These are now complete and the results are of some interest.

It will be noted that the neat cement without gypsum increases in strength to 28 days, but that from that time on to two years it loses strength, so that at the end of that period it has no greater strength than at seven days. The case is even more exaggerated with sand mortar.

Where 5 per cent. of gypsum is added to the cement the strength is greater at seven days and somewhat so at 28 days. At one year the strength has slightly increased over that at 28 days, but in two years it has gone off to a very considerable extent. Sand mortar made with cement containing 5 per cent. of gypsum increased in strength to 28 days, but dropped off slightly after this.

With 10 per cent. of gypsum a neat cement mortar is very inferior in tensile strength at 7 days, and gains but little at 28 days. At the end of the year it reaches a tensile strength of nearly 1,000 lb., while at two years there is a slight diminution in strength. In the case of sand mortar made with such a cement, there is a constant increase in strength from seven days to two years, and at that time the sand mortar is the strongest of any that have been examined. This is striking and will point to the fact that, in the case of Vulcanite cement at least the presence of 10 per cent. of gypsum is a decided advantage.

That in these cases the presence of a large amount of gypsum is not injurious can be seen from the results of the boiling tests, pats of the cement being quite sound after steaming and boiling in both fresh and salt water.

When the pats are preserved in sea water those made from cement free from gypsum show light hair cracks on the bottom, while those containing 5 and 10 per cent. of gypsum are quite sound.

As a whole, the results show that no disintegration may be expected to arise, either in fresh or salt water, from the presence of gypsum as high as 10 per cent. when this is used with a standard rotary kiln cement from the Lehigh Valley, but that, on the contrary, the cement possesses decided advantages when used in this way.

Very truly yours, CLIFFORD RICHARDSON.

VULCANITE PORTLAND CEMENT BRIQUETTES.

Lot No. 1, neat cement; Lot No. 2, neat cement + 5 per cent. $CaSO_4$; Lot No. 3, neat cement + 10 per cent. $CaSO_4$.

TENSILE STRENGTH.

	Neat			3 parts sand		
	No. 1.					
7 days	760	756	760	360	366	362
28 days	900	868	894	376	370	368
1 year	820	832	820	300	300	300
2 years	770	760	782	320	300	312
	No. 2.					
7 days	920	880	926	340	334	342
28 days	950	956	944	420	426	419
1 year	980	600	960	370	368	374
2 years	792	820	836	380	420	386
	No. 3.					
7 days	540	590	590	154	160	160
28 days	580	600	594	200	194	210
1 year	962	950	968	410	390	406
2 years	884	920	942	486	490	482

BOILING TESTS ON PATS.

Three hours in steam and then 3 hours longer in boiling water. All detached from plate, otherwise sound.

Results in boiling sea water—same as above.

Preserved in sea water—copper tank:

No. 1. Light hair cracks on bottom and at thin edge, as seen under the "glass."

No. 2. Quite sound. $CaCO_3$ on top and some CaO on bottom—slightly warty.

No. 3. Quite sound. $CaCO_3$ on top and some CaO on bottom—slightly warty.

Preserved in plain water—galvanized iron tank:

No. 1. Adheres firmly to plate—sound.

No. 2. Adheres firmly to plate—sound.

No. 3. Adheres firmly to plate—sound. This briquette was accidently detached about a year ago or probably longer, but is otherwise in excellent condition.

THE HAVERSTRAW LANDSLIP.

SIR: The brickmakers of this city, up to eight years ago, obtained their clay and sand from a tract east of Rockland St. (see sketch map), and south of Clinton St., and since then from the tract north of Clinton St. Three years ago the top of the bank stood, as shown by full lines, practically on the east line of Rockland St. as far south as midway between Division and Clinton Sts., from thence southeast to Liberty St. and thence east to Allison Ave. At that time, as city engineer, I had occasion to examine and survey this locality and found a crack existing about as shown by the line of crosses, from 1 to 3 in. wide, and the material had dropped to the north and east about 8 in. vertically. I then notified the authorities that a bad slip was liable to occur at any time. At that time and ever since clay has been taken from the toe of the slope from *A* north and sand from about *C* nearly at the top of the bank. The material is blue clay with thin strata of quicksand running through it at an angle of about 15 deg., dipping toward the east, with sand on top to a depth of about 15 ft. The line of least resistance is at the east end of Division St.

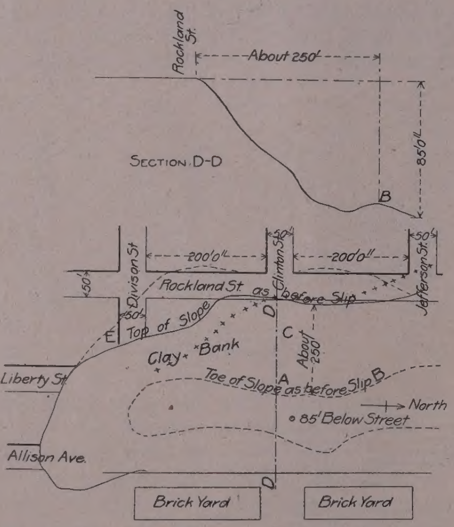


Diagram of Haverstraw Landslip.

My theory of the occurrence, and I think it is correct, is as follows: A previous slip about eight years ago, heaved up the material as at *B* on the cross-section. It formed a toe just heavy enough to counterbalance the weight pressing against it. By removing this material the counterbalance has at last been destroyed and a movement occurred about along the line of crosses. Then the line of resistance at *E* being the least, that point started and communicated its movement northerly along Rockland St., carrying everything with it back to about the dotted line.

The buildings located on both sides of Division St. east of Rockland St. and on the west side of Rockland St. were dropped into the pit. Another bad crack has opened west and south of the top of the present slope and as the present slope for some depth is only about ½ to 1 it will undoubtedly go soon. The point marked 85 ft. below Rockland St. is, I should judge, about 30 ft. below the river.

Twelve buildings and as near as can be told at this time 20 lives were lost. Most of the buildings were completely smashed and buried out of sight, even the bricks being broken to pieces.

Yours truly, CHAS. M. HILTON, C.E.

Haverstraw, Jan. 10.

MARSH ROADS.

SIR: With reference to the letters of Messrs. Saunders, Macrone and others in issues of Dec. 16 and 30 I will give my experience with marsh road construction. The roads of Northwest and North Central Iowa are extensively built through slough and bog land. I could name perhaps fifty or more roads that cross sloughs impassable for man or beast, unless the latter were provided with boat or mud boat or wings, over which there are now good earth roads. In a typical case we commenced on the ice after it had frozen sufficient to carry the teams, and laid a bed of flax straw, prairie hay or slough grass on top of the ice. This was spread about 16 to 18 ft. wide (the slough being about ¼ mile long), to the depth of 3 to 4 ft., and the travel soon had this compact. This bed protected the ice so it did not thaw out until the frost was out of the ground in the spring, when a ditching machine was procured and an open ditch cut to the sides of the approaches and as far back into the slough as practicable and all the water drawn off that was possible.

We then set teams to hauling manure and straw refuse from the barns and old strawstacks in the vicinity and dumped it to the sides of our roadway, so as to extend it out to about 25 ft. width. We then hauled in and covered all this straw bed, old as well as new, with 3 to 5 ft. of earth and this has always been as good a section of road as any in the community.

It might be well, however, to say that all those marshes here have a solid stratum which is also water-proof at a depth of from 4 to 15 ft. below the surface. The above marsh had open water in it 5 to 6 ft. deep in some parts, but could not be approached at any point from the fact that it was surrounded by a bog from 0 to 8 ft. deep, any part of which would carry neither man nor beast. Yours truly, A. H. GILLILAND,

Indianola, Ia. City Engr.

THE ESCALATORS at the store of R. H. Macy & Co., New York, proved very serviceable in handling the Christmas shopping crowds. From Dec. 1 to 24 inclusive, a careful count showed that the escalator carried more people away from the first floor than all of the elevators in the building, and it has always carried more people than the eight elevators in its immediate vicinity. In view of the great difference in floor space occupied by the elevators and the escalator, the capacity of the latter becomes still more noteworthy.